SEATTLE PUBLIC UTILITIES
WASTEWATER SYSTEMS PLAN

APPENDIX A

INFORMATION NEEDS FOR POLICY DEVELOPMENT

Appendix A
Information Needs for Policy Development

The following potential policies have been proposed for future development:
1. Sustainability
2. Annexation
3. Growth Pays for Growth
4. New and Re-Development Standards
5. Side Sewer Responsibilities
6. Alternative Strategies for Sewer Backup Prevention
7. Inflow/Infiltration (I/I) Control
8. Wastewater Odors
9. Build-Overs
10. Enforcement of Prohibited Discharges and Pre-Treatment Requirements
11. Flow Relationship with King County

This appendix provides brief descriptions of each potential policy including existing related policies, the reasons for developing a new policy, data/information needs, and the responsible parties for developing the new policy.

Potential General Policy for Future Development

Subject: Sustainability

Current Policy:

Sustainability principles and practices have applications to the Wastewater Utility in the areas of wastewater demand management, natural drainage systems, reduction of wastes, and energy conservation / reduction of pollutants and toxics to the environment. The City currently has the following policies which encourage sustainability:

1. Wastewater Demand Management
    - Water use reduction is targeted at 1% per year for 10 years, which also results in wastewater reductions. *(Strategic Business Plan – Environmental Policies)*
    - Sustainability principles are integrated into the design and construction for major infrastructure and neighborhood scale redevelopments *(2004 Environmental Action Agenda)*
    - Customers are encouraged to save water resources through education and financial incentives *(2004 Comprehensive Plan)*
2. Natural Drainage Technologies
    - Natural drainage systems in the public right-of-way are currently encouraged in the separated areas of the City *(2004 Comprehensive Drainage Plan)*
    - Natural drainage technologies on private properties in combined areas are being evaluated as a means of reducing combined sewer overflows (CSOs).
3. Energy Conservation / Reduction of Pollutants and Toxics to the Environment
    - Departments are to reduce the use and release of toxics into the environment for the O&M practices. They are to develop and implement best management practices for environmentally sensitive operations. *(Strategic Business Plan – Environmental Policies)*
    - No net increases in greenhouse gases from operations *(Strategic Business Plan – Environmental Policies)*
    - Businesses and residential customers are to be informed on the benefits and methods of controlling the release of contaminants and promoting environmental solutions. *(2004 Environmental Action Agenda and 2004 Comprehensive Plan)*

Reasons for Revising the Policies:

The existing sustainability policies in the Utility have the following gaps:

- Existing sustainability policies regarding wastewater demand management are focused on water use reduction, rather than the reduction of wastewater and stormwater demand on the sewers. The City does not have established targets or performance measures for reducing wastewater and stormwater demands. There is no process for measuring the effectiveness of demand management alternatives in reducing wastewater and stormwater demands on the sewers.

- While natural drainage systems in the public right-of-way are encouraged in separated sewer areas as a means for reducing stormwater demand, there is currently no policy for encouraging natural drainage systems in the public right-of-way in combined areas.
- Policies for energy conservation and the reduction of pollutants and toxics released to the environment are not yet tied to performance targets that are cost-effective.
- The Utility does not have a policy for reducing construction wastes. Policies for the use of recyclable construction materials or construction methods with less impacts have not been developed for the Wastewater Program.

New Policy Description

The City should revisit their policies regarding sustainability. The following policy changes should be considered:

- <u>Develop Procedures for Measuring Effectiveness of Demand Management Alternatives</u>: Procedures should be developed for measuring the cost-effectiveness of demand management alternatives in achieving SPU's levels of service.
- <u>Natural Drainage Systems in Public Right-of-Way in Combined Areas</u>: SPU should evaluate the benefits and costs of emphasizing natural drainage systems in the public right-of-way in combined sewer areas.
- <u>Energy Conservation and O&M Toxics Reduction</u>: Evaluate and develop cost-effective performance targets for energy use and reduction of toxic materials used and/or released into the environment. Evaluate the use of energy at pump stations and identify more sustainable energy sources and/or more energy efficient operations.
- <u>Construction Wastes</u>: Evaluate construction methods and materials to identify methods/materials that generate less wastes.

Data/Information Needs to Develop Policy:

- Performance and cost data on demand management alternatives
- Performance and cost data on natural drainage systems
- Energy use and costs for O&M activities
- Alternatives to reduce energy consumption
- Performance and cost data on O&M toxics reduction
- Alternative construction materials and methods

Responsible Parties

Wastewater Division
Surface Water Division

Potential General Policy for Future Development

Subject: Annexation

Current Policy

The City of Seattle ("City") periodically designates areas as potential annexation areas (PAAs) in the Seattle Comprehensive Plan, which is updated every 10 years. Designating an area as a PAA has significant implications, and therefore, the City exercises caution and prudence before doing so. A recent resolution by the Seattle City Council provided some guidance on the process by which an unincorporated area of King County can become a PAA:

- King County must execute Interlocal Agreements indemnifying the City of liabilities related to specific aged infrastructure (e.g., the existing 14th/16th Avenue South Bridge in North Highline/West Hill)
- The Executive must submit detailed and comprehensive information on operation and capital costs for each area, including but not limited to: assumptions about service levels and operation and maintenance costs, infrastructure upgrades, capital needs, FTE impacts, equipment costs, and any other costs associated with the annexation of the areas, as well as supporting documentation. Specific costs associated with police protection (additional personnel, equipment, police stations); other range of potential costs based on low-end vs. high-end service levels so that the City fully understands its potential financial liability. The supporting documentation must show how City departments determined the estimated costs.
- The Executive must submit a plan showing alternatives for how Seattle would pay for any increased costs that may result from annexation without negatively impacting existing service levels to Seattle residents.
- The City Council must determine that demonstrable progress is made on a more equitable regional funding mechanism and cost sharing plan for human services.
- Other jurisdictions abutting the areas must have indicated that they are not interested in also designating those areas of portions of those areas as PAAs.
- Objective polling of the areas must indicate that a majority of the population prefers to be annexed by the City. Seattle residents must also be polled to determine support for annexing those areas.
- The City must review existing statutes related to annexations to determine whether additions/changes to the statutes are needed to decrease the City's risks and costs associated with annexation.

Reasons for Developing an SPU Wastewater Utility Policy:

The current City policies/practices regarding annexation should be applied to SPU's Wastewater Utility to develop a wastewater specific policy process for analyzing PAAs. The process should consider various options related to annexing the wastewater infrastructure in a PAA. The process would serve as a basis for submitting to the

Executive a detailed assessment of the issues, concerns, and recommendations surrounding annexation as they pertain to wastewater infrastructure.

New Policy Description:

SPU's Wastewater Utility should develop a process which requires a comprehensive assessment of SPU's issues and concerns related to annexation. Potential issues which should be included in the policy are:

1. <u>Customer Relationship</u>: This includes side-sewer lateral ownership/responsibilities, existing contract agreements, pre-treatment requirements, disposal prohibitions for industrial customers, and service request response.
2. <u>System Condition</u>: This includes the structural condition of all infrastructure (ie, pipes, CSOs, manholes, catch basins, pumps, etc.), the amount of inflow/infiltration (I/I), the maintenance condition (ie, debris, fats-oils-grease, etc.), and the performance of the system (ie, hydraulic performance, pump station efficiency, etc.).
3. <u>Level of Service</u>: This includes the level of service (LOS) for backups, odors, customer response time, and discrepancies with SPU's LOS.
4. <u>Billing</u>: This includes service charges, connection fees, and issues related to outstanding Utility Local Improvement Districts (ULIDs)
5. <u>Operations & Maintenance (O&M) Responsibilities</u>: This relates to options for who carries on the O&M responsibilities, whether it be SPU or a local agency, and the full-time equivalents (FTEs) and associated costs.
6. <u>Capital Improvements</u>: This relates to needed capital improvements and their associated costs to address known system deficiencies.
7. <u>Treatment Requirements</u>: This relates to the wastewater treatment options and associated costs for the area, whether it be King County Wastewater Treatment Division (WTD) or others.
8. <u>Financial Liabilities</u>: This includes outstanding bonds and ULIDs.
9. <u>Regulatory Concerns</u>: This includes any regulatory concerns whether CSO-related, CMOM-related, or other.

Data/Information Needs to Develop Policy:

Developing an annexation policy will require an understanding of the potential impacts that issues regarding customer relationships, system condition, LOS, billing, O&M responsibilities, capital improvements, treatment requirements, financial liabilities, and regulatory issues will have on annexation.

Responsible Parties:

Wastewater Division
Finance Division

Potential General Policy for Future Development

Subject: Growth Pays for Growth

Current Policy:

The City of Seattle currently levies a Special Sewer Connection Charge through the Department of Planning and Development to cover the cost of new development. This charge is only levied when vacant property is developed.

Reasons for Revising the Policies

Since there is very little undeveloped land in the City, only a few thousand dollars is collected through this charge which does not cover the true cost of new development in the City. The water line of business levies a charge whenever a new "cut" or connection is made to the City water main. The City should analyze whether it is appropriate to have a similar charge for connections to the wastewater main line, and base the charge on the hydraulic capacity of the water main connection (this would be similar to assessing wastewater charges based on water use).

New Policy Descriptions

SPU should attempt to determine the amount of growth that will occur in Seattle in the coming years and identify high-growth areas. This should also include any possible annexation areas. SPU should identify the total revenue impacts of such growth including:

- Capital costs for facility upgrades to accommodate increased flow,
- Increased operations and maintenance costs,
- Treatment cost increases related to growth,
- Cost of implementing a special charge system,
- Taxes, and
- Potential revenue gains from new customers.

SPU should investigate various mechanisms for recovering excess costs including:

- Connection fee for sewer service connection,
- Special service charge,
- Requiring extension or size increase of sewer main,
- Etc.

If a connection charge is collected, it could be assessed at the same time the Special Connection Charge is assessed for the water connection, simplifying the collection process. A developer would be required to obtain a certificate to show that sufficient capacity exists in the system to accommodate their new development. The developer would have the option of installing any needed infrastructure directly rather than relying on the City to install it. Cost for other services that are in addition to those covered by the standard rates would be recovered through standard charges similar to those listed for the water line of business.

Data/Information Needs to Develop Policies

The information that would be helpful in developing this policy include:

1. Survey of how other utilities are addressing the issue of “growth pays for growth”. The survey should look at how other utilities are calculating the costs of development and what mechanisms they are using to pass these costs onto developers.
2. Historical case study examples or data in recent years of major developments in the City. The case studies and data should be used to calculate the historical cost impacts of new development. This would involve interaction with Finance, Operations, and those involved with capital projects.
3. Future projected development/growth. This will help to determine what will be the additional impacts of increased growth in growth areas. The costs of capital improvements and/or O&M increases to accommodate new growth should be calculated. The information in the Wastewater Systems Plan provides a base for this analysis.
4. The costs of implementing various options for charging developers fees for new or re-development.
5. Clarification of DPD’s position on “system development” charges in general and other Utility related capacity charges.

Responsible Party:

Finance Division
Wastewater Division

Second Tier Policy Issues

Subject: New or Re-Development Standards

Current Policy:

The City currently has the following policies regarding design and construction standards, incentives for demand management, and sewer use restrictions or limitations for new or re- development areas:

1. Stormwater in Separate Areas: All drainage shall be routed to the storm drainage system.
2. Stormwater Control in Combined Areas: Redevelopment is required to install on site detention to limit peak runoff from a design storm to less than 0.2 cfs/acre.
3. Sewer Flow Demand Management: The Plumbing Code defines minimum objectives in terms of sewage flow. SPU's Water Enterprise has incentives to further reduce base sewage flows by subsidizing the purchase of low consumption fixtures and appliances.
4. Sewer Connection/Use Restrictions/Limitations: Sewer connection requirements are currently defined by the side sewer permit requirements. Sewer use limitations are based on connection of impervious areas and/or toxic and contaminated wastes.

Reasons for Revising the Policies:

The current standards have the following gaps:

1. No Capacity Certification/Verification: There is currently no formalized policy/procedure related to certifying that the available sewer/drainage capacity in a specific area is adequate to serve the proposed development. There is no site-specific consideration of the increase in sewer and drainage flows due to re-zoning.
2. No Incentives for Increased Demand Management: There are currently no incentives for the developer to exceed the minimum objectives of sewer flow from the Plumbing Code.
3. No Threshold for More Stringent Stormwater Control Requirements in Combined Areas: The effectiveness of the 0.2 cfs/acre peak runoff contribution in combined areas depends on the size (area and density) of the proposed development. If the size of the proposed development leads to a significant increase in sanitary flows, then the limitation of 0.2 cfs/acre peak runoff contribution may still lead to a net increase in combined flows into the sewer system. There is no mechanism for reducing the peak runoff contribution even further when proposed zoning changes increase development areas or densities and sanitary flows beyond a certain threshold.

New Policy Description

The City should revisit their policies regarding new and re- developments. The following policy changes should be considered:

- Capacity Certification/Verification: A formal policy/procedure should be developed to certify that the existing site-specific sewer or storm drain system has sufficient capacity to accommodate increases in storm and drainage flows from a new development without a significant decrease in level of service. More stringent requirements should be created for developments in certain neighborhoods with known capacity issues.
- Incentives for Increased Demand Management: A policy/procedure should be developed which creates incentives for developers to decrease the sewer flow contribution beyond the Plumbing Code requirements.
- Thresholds for More Stringent Stormwater Control Requirements in Combined Areas: The existing policy should be revised to include a mechanism for increasing stormwater detention requirements above the existing standard where proposed zoning changes increase development areas or densities and sanitary flows beyond a certain threshold.

Data/Information Needs to Develop Policy:

- Sewer hydraulic modeling data to determine development area and density thresholds for increasing storm detention requirements
- Sewer hydraulic modeling data to verify capacity constraints in site-specific areas
- Cost benefit analysis of creating developer incentives for increasing demand management

Responsible Party(ies)

Wastewater Division
Surface Water Division

Second Tier Policy Issues

Subject: Side Sewer Responsibilities

Current Policy:

In the City of Seattle ("City"), the property owner is responsible for the installation and maintenance of the side sewer from the customer structure to the wye fitting in the City sewer main. This includes the segment of the side sewer in the public right of way (R/W). The City regulates the materials and hydraulic integrity of new and/or repaired side sewers through the side sewer permit process and limits construction work to approved side sewer contractors. Open cut construction is typically encouraged.

In the event of a side sewer failure, field crews will typically visit the site, but will not respond to the customer's problems when it appears (ie, through dye testing) that the problem is in the side sewer. The City currently has a practice of minimizing the payment of claims, particularly those concerning side sewers.

Currently, sanitary sewer overflows (SSOs) from side sewers are not regulated by the Department of Ecology (DOE).

Reasons for Developing a Policy:

The current policy does not take into consideration the whole life-cycle financial and social cost of the side sewers. Retail customer financial costs for side sewer failures and side sewer repair/maintenance, City financial costs to avoid payment of claims, and City and retail customer social costs for side sewer failures could justify the City revisiting their policy for ownership and/or maintenance of the side sewers.

New Policy Description

The City should revisit their policy for side sewer ownership and maintenance. The new policy should take into consideration the triple bottom line costs and risks of the side sewers including social and whole life-cycle financial costs. The following policy changes should be considered:

- Providing insurance program for funding side sewer failures
- Providing a loan program for private side sewer repairs
- Requiring condition assessment of the side sewers upon property transfer
- Encouraging the use of no-dig repair techniques where appropriate
- Providing inspection services
- Increasing education programs/campaigns to inform retail customers on side sewer ownership/maintenance responsibilities
- City ownership of the side sewers in the public R/W

The new policy should consider the implications of City side sewer ownership on SSO regulations.

Data/Information Needs to Develop Policy:

- Life-cycle cost analysis of side sewers, including:
  - Retail customer cost of installation and maintenance
  - City costs to respond to unplanned failures as well as operational costs to respond to customers with side sewer problems
  - Retail customer costs to repair broken side sewers and damaged public and private property
  - City costs to address side sewer-related claims
- Metric to account for City and retail customer social costs for side sewer failures
- Side sewer inspection costs
- Available technologies and options for side sewer repairs/maintenance
- Survey information on customers' interest in, and willingness to pay for side sewer services
- Clarification from DOE whether City ownership of the side sewers will expand the regulated sewer system for SSOs

Responsible Party(ies)

Wastewater Division
Customer Service

Potential Collection and Conveyance System Policy for Future Development

Subject: Alternatives Strategies for Sewer Backup Prevention

Current Policy:

The Seattle Municipal Code (SMC) 21.16.210 states that where a potential risk exists of backflow from the public sewer to a side sewer, the customer is responsible to take actions to reduce the risk. Two risk reduction options are identified: (1) provide a pumped transfer to the public sewer, and (2) install a backflow preventer and accept responsibility for its performance in preventing flooding. The Plumbing Code also requires that plumbing fixtures located below the elevation of the nearest upstream manhole be installed with an appropriate backwater prevention device to prevent sewer or drainage backups from occurring.

The 2004 Comprehensive Drainage Plan established a policy allowing for the purchase of property as a strategy to prevent flooding.

Reasons for Revising the Policies:

The current policies and practices have the following gaps:

1. There are no guidance procedures to identify when a customer is at risk of backflow and therefore responsible to take mitigation actions.
2. The Comprehensive Drainage Plan did not address purchasing property to prevent flooding caused by sewer backups in combined or partially combined areas of the City.

New Policy Description:

The City should revisit their policies regarding alternative backup control strategies. The following policy changes should be considered:

- Programs to enforce/encourage/inform customers regarding the installation of backflow preventers or pumped transfer systems to the public sewer
- Allowing the use of Wastewater Funds to purchase property as a strategy to prevent flooding caused by sewer backups

Data/Information Needs to Develop Policy:

- Benefit/cost analysis of a program to enforce/encourage/inform customers regarding backflow prevention and pumped transfer systems.
- Benefit/cost analysis and feasibility study of purchasing property to reduce storm-related sewer capacity backups in areas with a history of sewer backups.
- GIS database of properties with basements that are required by code to install backflow prevention devices.

Responsible Parties

Wastewater Division

Potential Collection and Conveyance System Policy for Future Development

Subject: Inflow and Infiltration (I/I) Control

Current Policy:

The City currently has no formal policies/rules/procedures to address I/I within its own conveyance system or its customer sources. Historically, the City considered I/I control projects on a system-wide basis (1980 201 Facility Plan – Sewage Collection System Modifications) and subsequently on a case-by-case basis. Generally, findings were that I/I control did not make economic sense. The City does undertake sewer rehabilitation projects, primarily to maintain the structural integrity of the system or to reduce maintenance. These projects do have a byproduct of reducing I/I, however that is not the primary purpose of the projects.

Based on the 1961 agreement with King County, the City is required to limit I/I peak levels to 1,100 gallons/day/acre in sewered areas constructed after 1961 or the City may be subject to a surcharge for excess flow. In 2002-03, King County limited inclusion of City areas to Thornton Creek and the north Seattle separated areas (above North 115th Street) in its comprehensive I/I Evaluation Program. King County's ability to enforce their I/I requirements has been limited, and therefore, the contractual I/I limits have not resulted in imposition of surcharges for excess flow on the City or a City policy or program to control I/I.

Reasons for Developing a Policy:

The City has three principle reasons to develop a policy for I/I control:

1. Achieve Levels of Service (LOS): I/I control may be a cost-effective means of achieving LOS. For example, I/I control may be used to address sewer capacity issues, thereby reducing sewer backups, CSOs, and flooding in combined areas. Other alternatives to correct these problems should also be evaluated in order to arrive at the most cost-effective approach.
2. Reduce Life-Cycle Costs of Assets: I/I control can be a tool to reduce life-cycle costs of assets such as pavement, pipes, and pumps. For example, I/I control can slow the rate of pipe or pavement degradation by reducing the loss of soil and pipe bedding resulting from I/I. I/I control can also reduce the volume of sewage that is pumped through pump stations, thereby increasing the service life of pumping equipment.
3. Achieve regional benefits and/or Meet Future King County I/I Requirements: King County is in the process of revising their I/I requirements to make them more enforceable. Once the requirements are developed and enforced, the City may be required to develop an I/I control policy to meet the new standard. Cost sharing based on regional and local agency benefits may improve cost effectiveness for local agency projects.

New Policy Description

The City should develop a formal I/I policy that requires I/I control to be studied and used where cost-effective as a means of achieving LOS, reducing life-cycle costs of assets, and meeting new I/I requirements from King County. The City should work with King County in developing King County I/I policies including development of cost sharing principles for I/I projects which have both local agency and regional benefits.

Data/Information Needs to Develop Policy:

- King County's new/revised policy for I/I. The City should participate with King County in development of King County's policy. Cost sharing principles should be established based on regional and local agency benefits.
- Levels of Service for sewer backups, CSOs, and flooding in combined areas
- Study of I/I contribution to sewer capacity issues such as sewer backups, CSOs, and flooding in combined areas
- Study of I/I contribution to pipe, pavement, and pump equipment deterioration
- Life-cycle cost analysis of using I/I control to reduce pipe, pavement, pump deterioration and regional treatment needs.
- Study, where applicable, how to deal with I/I excluded from the sewer system. In many cases, I/I is in the system because it was an easy solution to a drainage problem, which will reappear, if I/I is excluded.
- Contribution of I/I from side sewers versus sewer mains

Responsible Party:

Wastewater Division (working together with King County Wastewater Treatment Division)

Potential Collection and Conveyance System Policy for Future Development

Subject: Wastewater Odors

Current Policy:

The City currently has a policy for operating and maintaining the collection system to minimize odor complaints. In practice, the City seeks to limit odor complaints to 30 per year. Odor complaints had been recorded on the Hansen Computerized Maintenance Management System (CMMS) prior to its replacement with Maximo, and were reported in the Quarterly Metrics Report. When an odor complaint is received, Operations staff typically respond by first visiting the site to confirm the odor and its origin. Oftentimes, the odor's source is from King County in which case no remediation action is performed. If the odor's source is from SPU's wastewater system, then Operations staff respond by flushing, washing down, or cleaning the sewer line or pump station.

Reasons for Revising the Policies:

The current policies and practices have the following gaps:
1. The level of service for wastewater odors has not been established.
2. Operations staff indicate that the odor complaint recording procedures may under-report the actual number of complaints.
3. There has been no analysis to determine the costs and benefits of targeting lower or higher levels of service for odors.

New Policy Description

The City should consider revisiting their policy and level of service regarding wastewater odors. The following policy issues should be considered:
- <u>Level of Service</u>: The current level of service for wastewaters should be revisited. Number of odor complaints may not be the best metric for identifying level of service. Alternative metrics should be investigated, including the use of best management practices (BMPs) as a performance measure.
- <u>Planned vs. Reactive Odor Mitigation</u>: The current strategy to mitigate odors in the system is largely reactive, although there are some activities (ie, pre-treatment, grease-traps, sewer cleaning) that are benefiting odor mitigation even though that is not their primary intent. A policy should be developed which establishes the appropriate level of planned vs. reactive odor mitigation based on an analysis of the triple bottom line costs and benefits.
- <u>Implementation Strategies</u>: Implementation strategies such as scheduled sewer and/or pump station cleaning or flushing, chemical application, and capital projects should be considered where cost effective to reduce odors and achieve a level of service.
- <u>Targeted Odor Mitigation</u>: Some areas of the collection system are more susceptible to the production of wastewater odors. These areas include areas with

higher biological oxygen demand (BOD), higher concentrations of grease, sections of sewers with depressions or slow velocities, sections where sewer age is very high, gravity sewers immediately downstream of pump station force mains, and sewers with high corrosion rates. Consideration should be given to targeting planned odor mitigation activities to the most susceptible odor generating areas.

Data/Information Needs to Develop Policy:

- Data on wastewater odor complaints
- Research on various strategies to mitigate odors
- Odor potential map showing areas with higher BOD, grease, sewer depressions, gravity sewers downstream of force mains, and sewers with high corrosion rates. GIS information such as locations of restaurants, slopes of sewer pipes, historical odor complaints, locations of force mains, locations of identified sewer depressions, locations with high sewer age, and other factors contributing to odor can be used to create this map in GIS.
- Hydraulic model calculation of sewer velocities, indicating areas with velocities less than 3 fps during summer months. Hydraulic model calculation showing areas with high sewerage age. Results of the hydraulic model should be overlayed onto the GIS to create the odor potential map.
- Analysis of triple bottom line cost-benefits of implementing proactive strategies to mitigate odors.

Responsible Parties:

Wastewater Division
Drainage and Wastewater Operations Division

Potential Collection and Conveyance System Policy for Future Development

Subject: Build-Overs

There are many locations in Seattle where a house or other building is constructed above a City-owned sewer or storm drain pipe. The City may or may not have an easement for the pipe. These build-overs, as they are called, affect SPU's ability to inspect, clean, maintain, repair, or replace these pipes. In the event of a catastrophic failure such as a sewer collapse or creation of a sinkhole, these situations could cause significant property damage or injury.

In order to reduce the risk of property damage and protect public safety, as well as provide maintenance access to these facilities, SPU has had a long-standing unwritten policy of requiring that certain mitigation measures be taken. Because this policy has not been written down or included in City Codes and regulations, there have been recent incidences, as well as many in the past, of development occurring without any safeguards.

Reasons for Revising the Policies

The development of a written policy and related procedures for build-overs will help ensure that SPU has access to its facilities and that those responsible for permitting development understand this policy. The policy should be written into City regulations to ensure that it is carried out.

New Policy Description

SPU must maintain access to its facilities for maintenance and eventual replacement.

If a property owner wants to construct a building over an SPU-owned sewer or storm drain, the property owner must either:

1. Reroute the line around the building and preferably into a City-owned right-of-way, or
2. Replace the line where it would run under the building with ductile iron pipe with a maintenance hole for access at each end.

In addition, SPU should obtain an easement for the pipe if one does not exist. If the property owner chooses to build over the pipe, they must provide the City with a Hold Harmless Agreement for any injury or damage that might occur from the pipe.

SPU should work with the Department of Planning and Development (DPD) to get these requirements written into the appropriate sections of the Seattle Municipal Code and to institute procedures to ensure their compliance.

Responsible Party:

Wastewater Division (together with DPD)

Potential Collection and Conveyance System Policy for Future Development

Subject: Enforcement of Prohibited Discharges and Pre-Treatment Requirements

Current Policy:

The Seattle Municipal Code 21.16.300 currently bans substances that could cause hazard to SPU operations staff, create blockages in the sewer system, or create objectionable odors. The following substances are specifically prohibited from being discharged to the sewers: (1) substances with temperatures greater than 150 degrees F, (2) solid materials that could cause blockages, (3) high strength wastes, (4) noxious or malodorous substances, (5) concentrations of fats, oils, and grease (FOG) greater than 100 ppm, (6) materials creating visible accumulations of grease. Customer education is the primary method to reduce unacceptable discharges.

Seattle Municipal Code 21.16.310 contains rules for pretreatment of wastes to modify constituents to acceptable levels for discharge to the sewers. Certain restaurants operations are required to install grease separators pretreatment facilities. Pretreatment permitting requirements and fees have been established, and design guidelines have been developed to identify minimum sizing criteria and operational procedures. Grease trap inspections are periodically performed by staff in the Community Service Division.

Reasons for Revising the Policies:

The current policies and practices have the following gaps:

1. The role of SPU Operations in the enforcement of prohibited discharges is not clear. There is no defined procedure for enforcement of the policy.
2. Pre-treatment rules only apply to restaurants. There may be other significant operations/facilities that discharge prohibited materials to the sewers.
3. EPA has recently revised design guidelines for grease traps. It is possible that the City's grease trap design guidelines may need to be updated to match EPA's new guidelines.

New Policy Description

The City should revisit their policies regarding enforcement of pre-treatment requirements and prohibited discharges to sewers. The following policy changes should be considered:

- Revise/update design guidelines for grease traps
- Develop a procedure for enforcement of the prohibited discharge policy. Define when (e.g., new construction only, tenant improvements) requirements should be enforced. Define the group responsible for enforcing the policy and procedure.
- Expand the pre-treatment rules to apply to other facilities/operations
- Develop a systematic inspection program for private pretreatment facilities, potentially linking to critical sewer inspections.

Data/Information Needs to Develop Policy:

- Performance benchmarking of effectiveness of existing pre-treatment requirements
- Cost/benefit analysis of enforcing prohibited discharge policy
- Cost/benefit analysis of expanding pre-treatment rules to other facilities
- GIS database of private pretreatment facilities

Responsible Parties:

Wastewater Division
Scientific and Technical Services Division (Source Control and Monitoring)
Drainage and Wastewater Operations Division

Potential CSO Control Policy for Future Development

Subject: Flow Relationship with King County

Current Policy:

In 1961, the City of Seattle ("City") agreed to deliver its combined wastewater flows to King County. King County's Wastewater Treatment Division (WTD) agreed to accept all of the City's wastewater subject to reasonable rules and regulations that could be adopted from time to time.

Currently, King County accepts peak flows from the City equivalent or less than the 1961 development/sewering conditions from both combined and separated sewer areas. For new sewered areas, peak flows are limited to wastewater flows + 1,100 gallons/acre/day inflow and infiltration (I/I). King County uses capacity in its trunk sewers to store combined flows, thereby reducing King County combined sewer overflows (CSOs).

Reasons for Developing a Policy:

The City and King County have differing understandings of the flows that King County should accept from the City. The City believes that King County is obligated to accept the peak hydraulic flow capacity of the 1961 pipelines. The City has planned CSO storage projects that do not increase the peak hydraulic flow of the 1961 pipelines, but lengthen the duration of peak flows from the City to King County. King County is concerned that City's CSO storage projects will exacerbate their CSO problems and increase volumes that the County must treat. In principle, the divergence in interpretations could be significant, because it could impact capital projects and CSO control for both the City and King County. In practice, agreement between King County and the City on a single interpretation of 1961 flows is not critical. However, agreeing on a general approach to dealing with flows on a case-by-case basis is critical to ensuring that the most cost effective and beneficial CSO control options for both King County and the City are pursued.

In addition, while King County's practice of storing flows in its trunk system is a cost effective way of reducing its CSOs, it can, on occasion, have an adverse impact on CSOs and flows in the City's system.

New Policy Description

The City should work together with King County to develop a policy for addressing the flow relationship between the two agencies. The new policy should consider the overall least cost solution for both agencies to provide established levels of service, meet regulatory-required combined sewer overflow (CSO) targets, and achieve environmental goals. The new policy may consider differing interpretations of peak flows equivalent to 1961 development/sewering conditions depending on which interpretation leads to the greatest cost-savings for the City and King County. The new policy should also establish an approach to cost-sharing on joint CSO control projects which achieve benefits for both the City and King County.

The City and King County also need to work to assure that the King County practice of storing combined flows in their trunk sewers does not adversely affect flows and CSOs in the City's system.

Data/Information Needs to Develop Policy:

- Hydraulic grade line and flow interaction between City and King County sewer systems
- Benefits/costs of differing interpretations of 1961 flows on City and King County projects
- Method/process of allocating costs/benefits of CSO control projects to King County (region) and the City.

Responsible Party:

Wastewater Division (working together with King County Wastewater Treatment Division)

SEATTLE PUBLIC UTILITIES
WASTEWATER SYSTEMS PLAN

APPENDIX B
SEWER CAPACITY ANALYSIS

DRAFT FACT SHEET

SPU Capacity Assessment Methodology

Purpose

The purpose of this fact sheet is to document the assumptions, techniques and outcomes in the assessment of capacity of SPU mainline sewers.

General

Existing claims data and backup reports associated with capacity restrictions by SvR were examined. Backups and claims were associated with major storms. Review of this data indicates that backups and claims that are most probably capacity related are linked to high intensity, short duration rain events, i.e., thundershowers or convergence zone storms. Some were linked to longer storms containing shorter periods of high intensity.

Rain events causing backups were further examined to identify their approximate frequency of occurrence. This was done by comparison of the rainfall in various time periods against the Intensity-Duration-Frequency (IDF) curves prepared for SPU by MGS Engineering (Analysis of Precipitation-Frequency and Storm Characteristics for the City of Seattle, MGS Engineering Consultants, December 2003). See Figure 1 for example. It was found that storms exceeding a 5-yr event occurred several times in the period of 1987-2003 at various locations in the city.

As a result of this analysis, it was decided that the capacity analysis should be conducted using short-term synthetic rainfall events. These were prepared according to the MGS Engineering study. The design storms created are shown in Figure 2. A comparison of the 5-yr design storm to an actual storm on May 5, 2003 that resulted in backup complains in the NW Ballard area is shown in Figure 3.

Flow Model

Existing SPU Infoworks models of the CSO systems were obtained and examined. A new model was constructed in Mouse for the Lower Queen Anne area. Using actual storms associated with backups and claims or using design storms, these models indicated that significant portions of the modeled areas would surcharge.

Development of full system models with Infoworks or Mouse was not possible. Thus, a simplified technique was used to identify pipes in the system that were most at risk for causing backups. This simplified technique is based on the assumption that the total length of pipe upstream of any given pipe in the system is representative of the acreage tributary to that specific pipe. Further, it is assumed that the demand on the pipe is a function of the upstream tributary area depending on imperviousness and population. Use of this technique involved the following activities:

1. Use of the SPU GIS to develop an average sewer density. Several areas were examined leading to an estimated average of 182-ft of sewer per developed acre.

2. Using pipe tracing techniques SPU GIS staff provided a table giving the total length of pipe upstream of every pipe in the system. The total length includes drainage pipes where storm drains are connected to the sanitary system.
3. Each pipe was assigned a general sewer type and land use type by intersecting the SPU land use coverage with the pipe coverage.
4. General imperviousness values were developed for various land use types from examination of existing hydraulic models. The following generalizations were identified. It is apparent from existing models that the imperviousness in the south end of Seattle is lower than in the north. Adjustments were made accordingly.

Sewer Type	**Land Use Type**	**Generalized Percent Imperviousness**
Combined General	Residential	26%
	Non-residential	56%
Partially Separated General	Residential	14%
	Non-residential	26%
Combined-South End	Residential	14%
Partially Separated-South End	Residential	7%

5. The Santa Barbara Unit Hydrograph model was used to establish runoff rates from the various land use/sewer type classes. The runoff was related to total pipe length using the average sewer density described in item 1. The time of concentration was related to total pipe length using a minimum value of 10-minutes. The results of the calculations were expressed in mgd of flow per foot of upstream pipe length (a typical relationship is shown in Figure 4). Values from these relationships were selected for each pipe depending on the upstream length and the associated land use.
6. Flow demands for totally separated areas were developed using previous work by King County in the north end. King County calibrated flow models for the inflow to the Carkeek Park pumping station, and for areas tributary to the Mathews Beach pumping station as part of their I/I study. These analyses provided peak sewer flows with specified recurrence intervals. The values of flow in mgd/ft of pipe for separated areas are shown in the table below.

Sewer Area	**Flow Recurrence**	**Flow Demand, mgd/ft**
Carkeek	2-yr	0.00009
	5-yr	0.00011
	10-yr	0.00012
	20-yr	0.00014
Matthews Beach	2-yr	0.000026
(used for all other areas)	5-yr	0.000029
	10-yr	0.000031
	20-yr	0.000033

7. The flow demand for each pipe determined using the assigned land use and the potential flow depending on upstream length determined in item 5 or 6 was then compared to the calculated Manning's capacity. This provided a table of pipe segments which were capacity challenged for each storm frequency (2-, 5-, 10-, and 20-yr).
8. Any pipes downstream of CSOs were eliminated from the analysis on the assumption that excess demand is controlled by overflow.
9. If the excess flow demand predicted were only slightly greater than the calculated Manning's capacity, the impact of the excess flow might be slight. Small increments of flow over the Manning's capacity could produce minor surcharge that would not cause a problem in the system. Accordingly, a simplified technique was developed to assess the magnitude of the excess flow relative to capacity. The potential rise in hydraulic grade line (HGL) across each selected pipe based on the flow projection, pipe diameter and slope was computed. The elevation of the HGL so computed was compared to the ground elevation and pipes were selected for further analysis where the computed HGL was less than 10-ft below the ground surface. 10-ft was chosen as representing a risk for basement backups.
10. The maintenance holes (MH) selected in item 8 were submitted to SPU for a GIS analysis of potential affected parcels. The SPU staff searched upstream of each MH submitted to locate upstream MHs with invert elevations below the given HGL. Parcels attached to the intervening pipes were identified. Figure 5 shows the technique schematically.

Prioritization

The above activities resulted in a list of pipes which have a capacity less than the predicted flow demand for each of the design events. These were further analyzed to select only those that have the highest risk of causing a backup. The resulting pipe list was prioritized for further attention into three groups according to relative risk. Prioritization involved ranking the pipes using the following factors:

1. Association with previous backup reports, or claims associated with significant rain storms, especially if there were multiple occurrences in the neighborhood, and pipes were associated with higher frequency (e.g. 2-yr) events.
2. Coincidence with areas of high projected growth
3. Relative impact, i.e., the number of parcels potentially affected as identified in the analysis step 9 above.
4. The occurrence of clusters, i.e., where there were sequences of several pipes and other factors were in play.
5. Association with other major projects or developments.
6. Association with areas identified as problematical by SPU operations staff.

Coincidence with "critical" pipes identified by the SPU risk model was also considered as a prioritization factor. But it was found that nearly all the capacity challenged pipes were on the critical list.

Three priorities were identified: Priority 1 pipes were associated with several of the ranking factors described above-these were also subcategorized to indicate the areas of highest likelihood; Priority 2 pipes were not strongly associated with the above factors except for the occurrence of parcels potentially affected. Priority 3 pipes were not associated with any of the above factors – no connecting parcels were identified, which may be a function of the technique (see Figure 5).

The priorities are summarized in the following tables. Locations and selected pipes by event are depicted on a map accessible in a PDF files – CTRL+Click here for map.

Table 1 - Summary of Priority Pipes

		Number of Parcels Potentially Affected					
Event	**Priority**	**Single Family**	**Multi-Family**	**Ind/Comm**	**Sum**	**Number of Pipe Segments**	**Cost, Million $**
2-yr	1	1483	149	423	2055	203	$23.9
	2	1463	176	321	1960	318	$26.0
	3	0	0	0	0	139	$12.4
	Sum	2946	325	744	4015	660	$62.3
5-yr	1	1832	193	493	2518	300	$36.9
	2	1869	222	443	2534	460	$38.4
	3	0	0	0	0	230	$20.7
	Sum	3701	415	936	5052	990	$96.0
10-yr	1	2039	245	571	2855	379	$46.8
	2	2342	328	584	3254	604	$77.8
	3	0	0	0	0	346	$32.7
	Sum	4381	573	1155	6109	1329	$157.3
20-yr	1	2221	262	628	3111	460	$59.1
	2	3088	449	738	4275	729	$97.8
	3	0	0	0	0	502	$44.3
	Sum	5309	711	1366	7386	1691	$201.2

Table 2 – Summary of Priority 1 Areas

Priority 1 Area No.[a]	Associated Prioritization Factors	Replacement Cost, Million $	Remarks
1	1, 3, 4	2-yr – $0.34 5-yr – $0.68 10-yr – $0.91 20-yr – $1.09	Backup associated with October 2003 storm. Actual flow generation from this area may be less than the Carkeek average and should be verified.
2	1, 3, 4	2-yr – $3.63 5-yr – $4.66 10-yr – $5.18 20-yr – $5.75	Backup associated with January 1997 rain-on-snow event. Actual flow generation should be verified. Looping of pipes indicates a possible error in selection technique and should be verified
3*	1, 3, 4, 6	2-yr – $0.19 5-yr – $0.24 10-yr – $0.27 20-yr – $0.51	Multiple backups have occurred in this neighborhood 1988-2003. Previous SPU work to correct (per Joe Talbot)
4	1	2-yr – $0 5-yr – $0 10-yr – $0 20-yr – $0.39	Observed backup occurred during approximate 5-yr storm. No parcels identified. Possible maintenance problem.
5	3, 4	2-yr – $1.02 5-yr – $1.41 10-yr – $1.72 20-yr – $1.88	Large neighborhood cluster. No previous complaint or backup reports. Selection should be verified.
6*	1, 2, 4	2-yr – $1.27 5-yr – $2.59 10-yr – $3.74 20-yr – $4.93	Multiple backup reports 1996-2003. High growth area-lower Queen Anne
7	2, 3, 4, 5	2-yr – $3.08 5-yr – $3.47 10-yr – $3.85 20-yr – $4.84	May be associated with Viaduct replacement
8*	1, 2, 3, 4, 6	2-yr – $2.84 5-yr – $5.67 10-yr – $7.58 20-yr – $9.73	South Lake Union redevelopment
9	1, 3, 4	2-yr – $0.57 5-yr – $1.04 10-yr – $1.35 20-yr – $1.42	Claims associated with 3 significant rainfall events 1988-2003
10	1, 4	2-yr – $0.24 5-yr – $0.81 10-yr – $1.25 20-yr – $1.81	Pipe connectivity (looping) may have resulted in an inadvertent selection-verify. Backup reports and claims associated with two significant rainfall events.
11*	1, 3, 4, 6	2-yr – $2.18 5-yr – $3.76 10-yr – $4.83 20-yr – $6.03	Associated with Madison Valley problem. Backup reports and claims associated with three significant rainfall events.
12	1, 4	2-yr – $0.55 5-yr – $0.80 10-yr – $0.83 20-yr – $0.86	Backup reports and claims associated with two significant rainfall events
13	1, 2, 3, 4, 5	2-yr – $1.67 5-yr – $3.64 10-yr – $5.54 20-yr – $7.25	May be associated with Viaduct replacement. Claims associated with one significant rainfall event
14	1, 4	2-yr – 5-yr – $0.12 10-yr – $0.12 20-yr – $0.25	Claim associated with one significant rainfall event
15*	1, 3, 4, 6	2-yr – $1.42 5-yr – $1.97 10-yr – $2.41 20-yr – $3.31	Multiple occurrence of backup reports
16	3, 4	2-yr – $2.70 5-yr – $3.21 10-yr – $3.77 20-yr – $4.15	Flow generation assumptions may be too high. CSO operation may affect result. Verify actual percent imperviousness and account for CSO structures

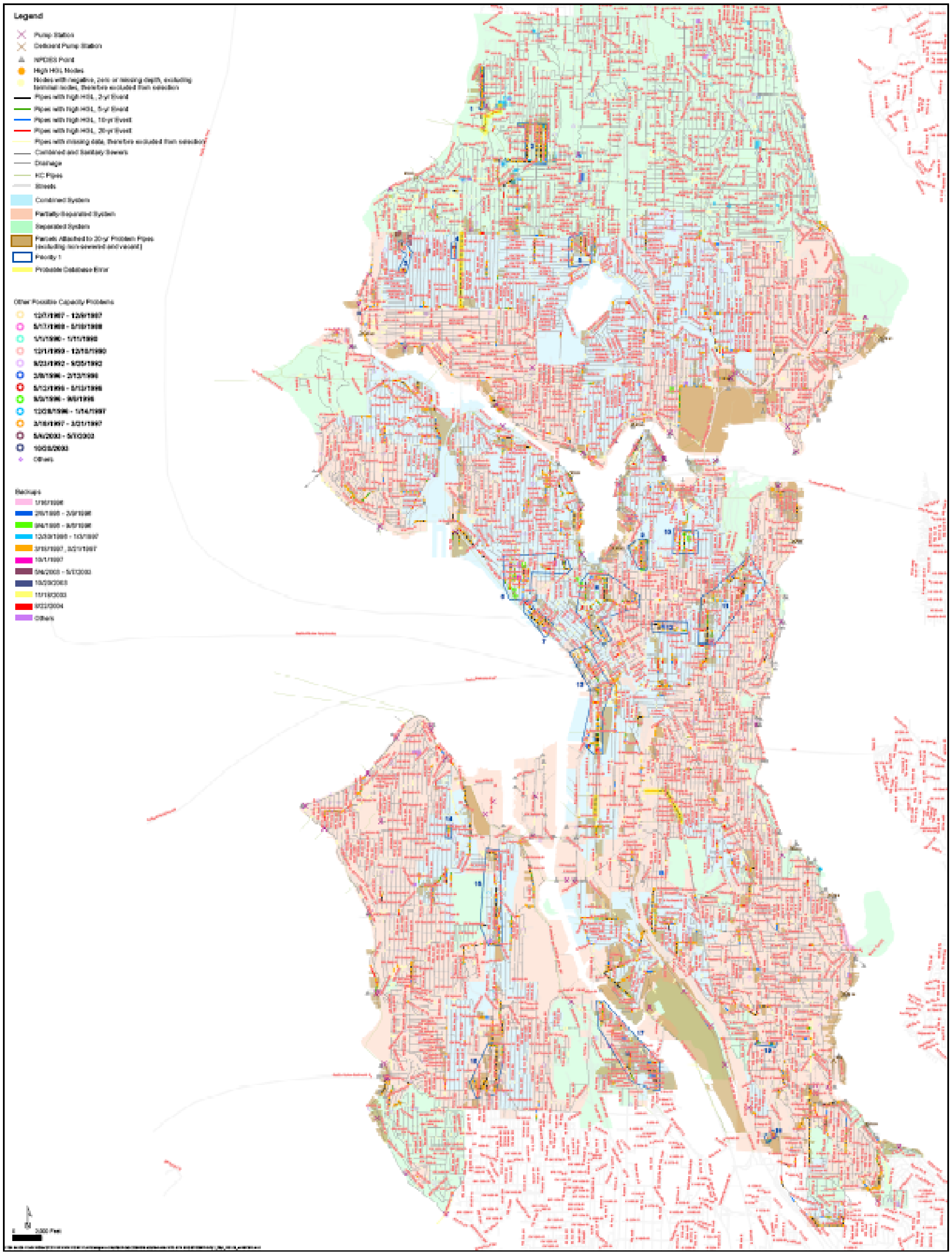
Priority 1 Area No.[a]	Associated Prioritization Factors	Replacement Cost, Million $	Remarks
17*	1, 3, 4, 5, 6	2-yr – $2.07 5-yr – $2.55 10-yr – $3.23 20-yr – $4.49	Associated with South Park drainage considerations
18	1, 3	2-yr – $0.01 5-yr – $0.05 10-yr – $0.05 20-yr – $0.08	Backup reports associated with one significant rainfall event
19	1, 3	2-yr – $0.13 5-yr – $0.21 10-yr – $0.23 20-yr – $0.33	Backup reports associated with one significant rainfall event

[a] Refer to system map with Priority areas labeled-click here

* Areas with the highest likelihood of need

Table 3 – Selections known to be Probable Errors due to Database Problems (Highlighted in Yellow on the Priority Map)

Location	Cost, million $	Remarks
Broadview from NW 120th to NW Carkeek Park Rd Priority 3	2-yr – $0.48 5-yr – $0.75 10-yr –$0.99 20-yr – $1.14	Problem corrected by SPU Broadview project. New pipes not yet in GIS database
15th Ave NW from NW 85th to NW 65th Streets	2-yr – $2.26 5-yr – $2.42 10-yr –$2.59 20-yr – $2.65	Database indicates this pipe collects flow from a significant area north of NW 85th with a split in flow at NW 85th and 15th NW. Actual flow split should be verified and the analysis refined to account for any area tributary north of NW 85th
1st Ave S between S Hanford and S Lander Streets	2-yr – $3.59 5-yr – $3.82 10-yr –$4.46 20-yr – $4.92	Database indicates a split with flow leaving the King County line in S Hanford St and proceeding north on 1st Ave S. The analysis technique has assigned the entire upstream length of SW Seattle to this pipe which is not representative. Connection should be verified and the potential for flow to proceed down this line be accounted for.
Beacon Ave S from S Hanford St to S Bayview St and S Bayview to 8th Ave S	2-yr – $4.89 5-yr – $5.65 10-yr –$6.10 20-yr – $6.19	The database indicates that an 8-in line connects to the S Hanford trunk and proceeds down Beacon Ave S. The analysis technique has assigned the entire upstream length of SW Seattle to this pipe which is not representative. Connection and potential for flow down this pipe should be verified.



Selected Capacity Challenged Pipes and Priority 1 Areas. [Click here for PDF]

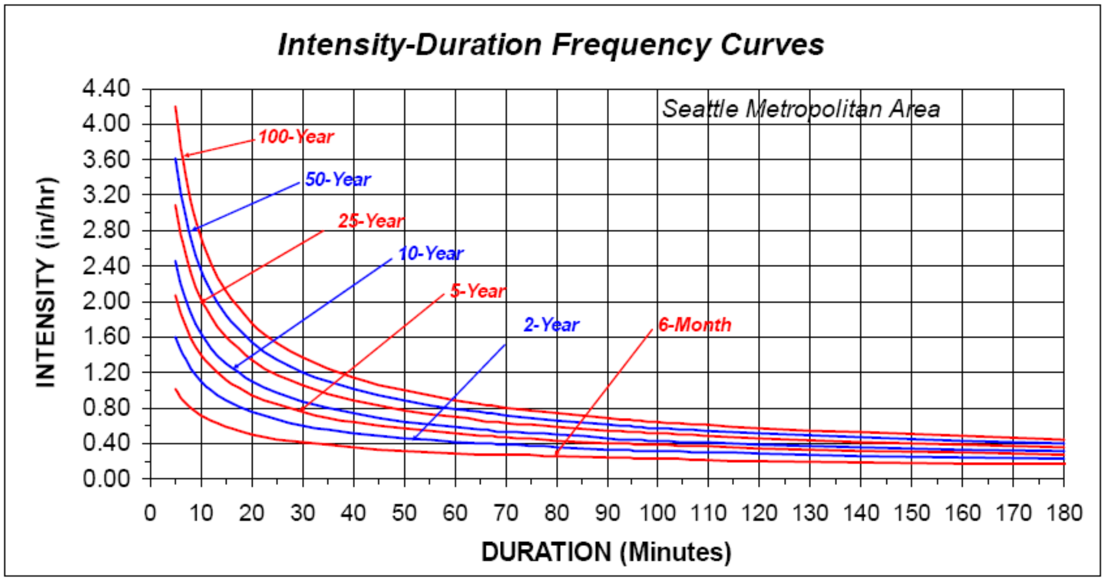


Figure 1 – Short-Term IDF Curves for the Seattle Metropolitan Area (MGS Engineering)

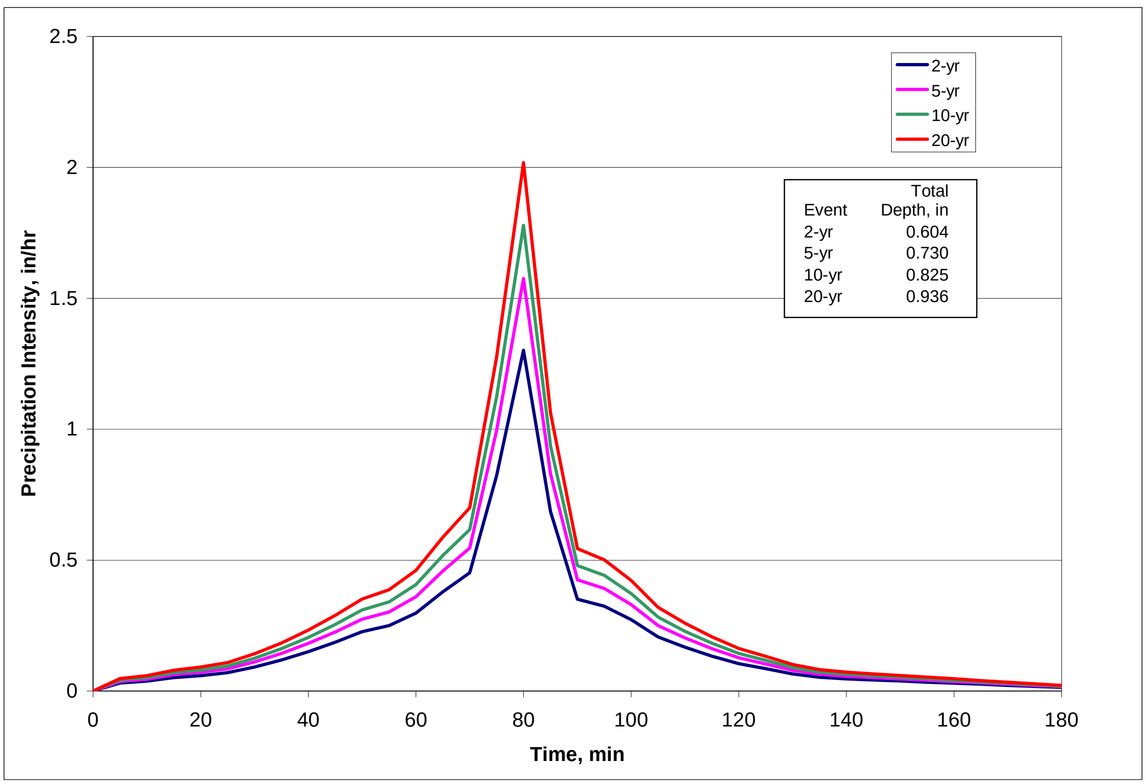


Figure 2 - Short-Term Synthetic Design Storms

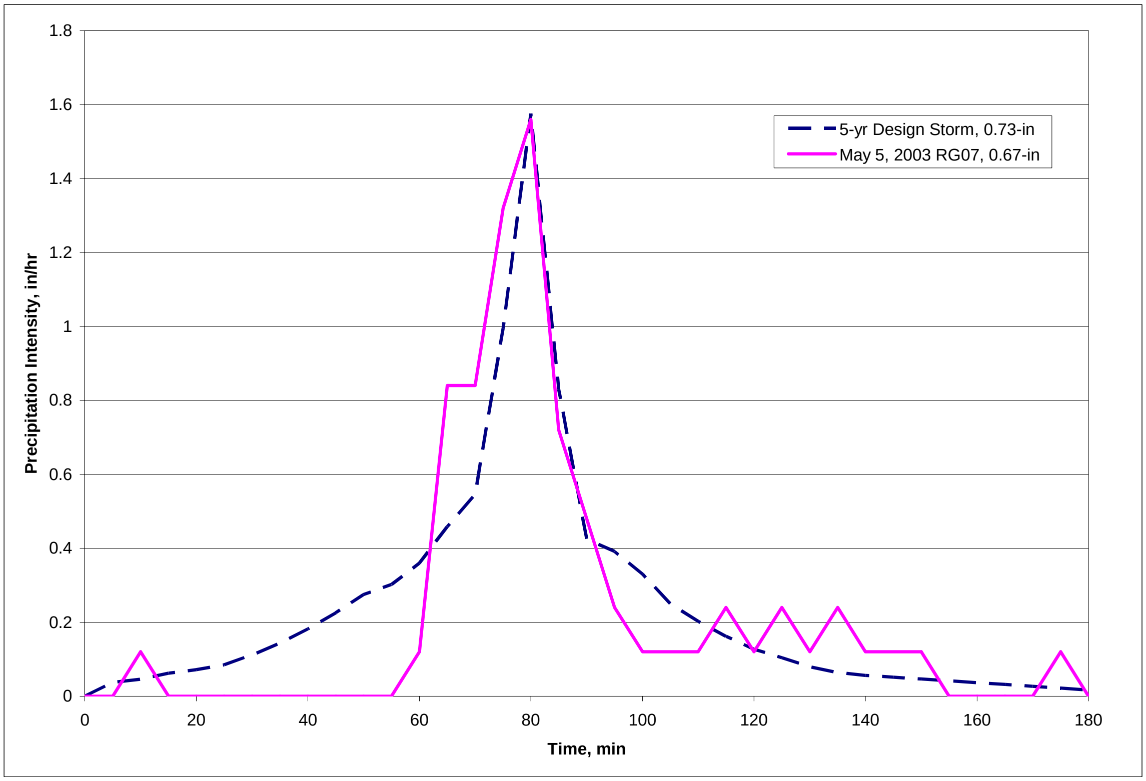


Figure 3 - Comparison of 5-yr Design Storm to an Actual Event at RG 07, 5/5/2003

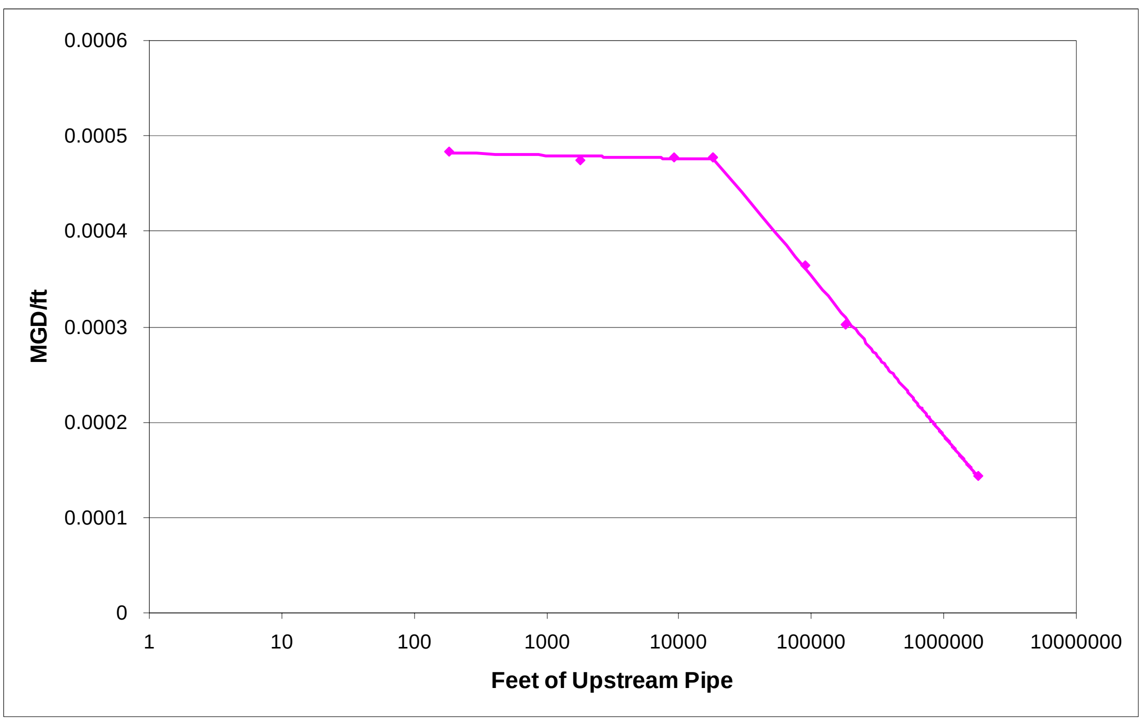


Figure 4 – Relationship of flow per foot of upstream pipe developed for a combined residential land use using the SBUH model and a 2-yr design storm. The break in slope corresponds to a time of concentration of 10-minutes.

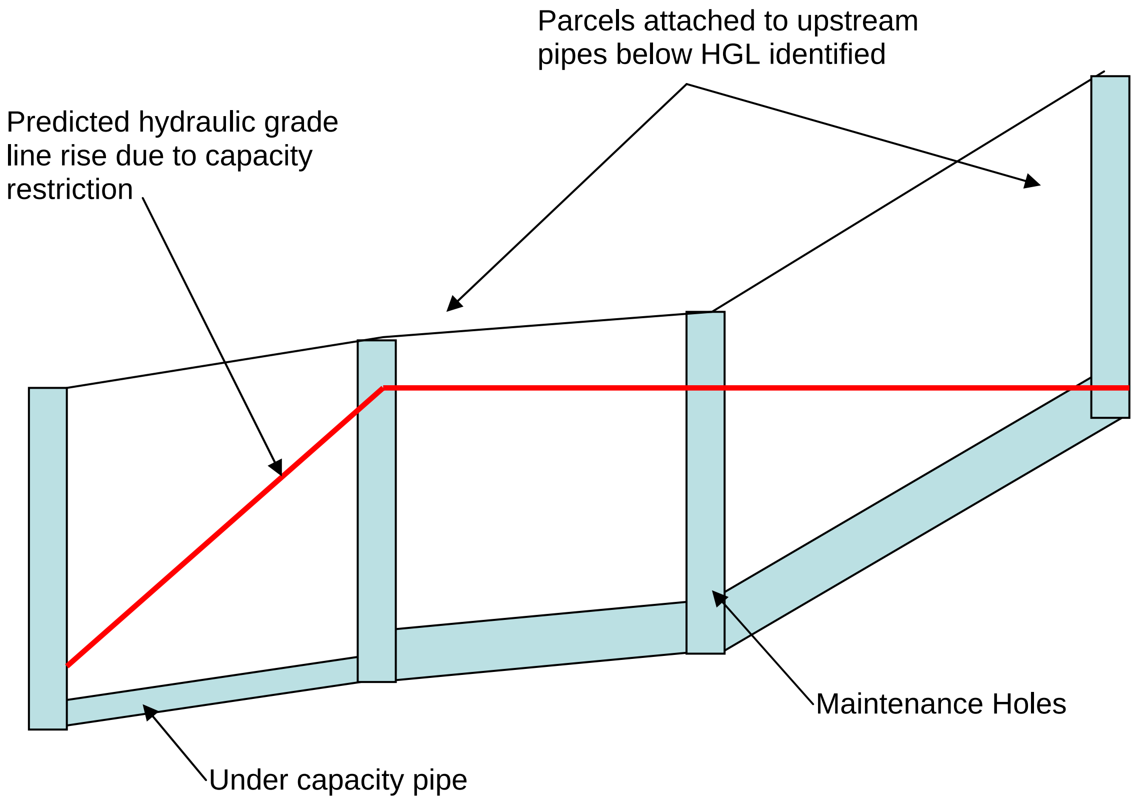


Figure 5 – Parcel Identification Technique

SEATTLE PUBLIC UTILITIES
WASTEWATER SYSTEMS PLAN

APPENDIX C
SUMMARY OF COST ESTIMATING METHODOLOGY

Appendix C
Summary of Sewer Relining and Open Cut Replacement Cost Estimating Methodology

SPU provided Brown and Caldwell (BC) with information on each of their over 33,000 gravity sewer pipes. The information included pipe identification number, year of installation, average depth of pipe, diameter, length, and material type. Based on this data, rehabilitation or replacement costs were developed.

Relining (CIPP) Cost

Cast In Place Pipe (CIPP) by *Insituform* was used as the basis for rehabilitation costs. Rehabilitation is preferred to traditional open cut full replacement due to the reduction in capital cost. Pipes that were deemed unsuitable for CIPP included existing pipe that have already been relined, pipes with diameters 60” or greater, or pipes with remaining useful life of 5 years or less. At this time, SPU does not reline previously relined pipe. In addition to the base price for installation of CIPP, traffic control, sewer bypass pumping, cleaning, and cost for lateral connections were added. Traffic control and bypass pumping cost estimates are listed in Table 1. Bypass pumping cost are additive for pipes of 15-inch diameter or greater. Cleaning costs were estimated assuming $0.25/linear foot/inch diameter and lateral connection were $250 per connection every 20 feet of pipe length. Installation, cleaning, and lateral connection costs were provided by *Insituform*. Traffic control and bypass pumping were calculated using *Means*.

After determining the price per foot based on the pipe size and depth of bury, it is then multiplied by the length to get the pipe segment replacement costs. The replacement cost is then multiplied by 1.15 and 1.4 to get the total cost. These additional costs include taxes, allied costs, and contingency.

Open Cut Cost

For the pipes deemed unsuitable for CIPP rehabilitation, open cut replacement costs were developed. Tabula was used to calculate cost for open cut construction of new pipe. Tabula is a program used by King County for planning level cost estimating. Costs were developed for a variety of pipe diameters. Also, the pipe depths were broken into two major categories; pipes with an average depth between 0 and 16 feet and those with average depths greater than 16 feet. Table 2 details the cost used for each linear foot of new pipe constructed.

The assumptions used to calculate the costs in Tabula are as follows:

- The fill will be imported
- Average Manhole spacing is 500 feet
- Trench Safety requirements are standard
- Dewatering is minimal
- Existing Utilities are average

- Traffic is light
- No Required Easements necessary
- No Land Acquisition is necessary
- Length of job is greater than 1000 feet.

After determining the price per foot based on the pipe size and depth of bury, it is then multiplied by the length to get the pipe segment replacement costs. The replacement cost is then multiplied by 1.15 and 1.4 to get the total cost. These additional costs include taxes, allied costs, and contingency.

As part of our analysis, we compared the values produced by Tabula to a cost table developed by SPU to estimate construction costs for open cut pipe replacement. The values produced by Tabula and sited by SPU are in the same range.

Table 1 Replacement Cost Using CIPP ($/LF)			
Insituform			
Pipe Size (in)	**Price ($)/LF**	**Traffic Control (Labor and Equipment) $/LF**	**Sewer Bypass Pumping $/LF**
3	$ 42.00	$ 1.32	NA
4	$ 42.00	$ 1.32	NA
6	$ 42.00	$ 1.32	NA
8	$ 42.00	$ 1.32	NA
10	$ 54.00	$ 1.32	NA
12	$ 66.00	$ 1.32	NA
14	$ 81.60	$ 1.32	NA
15	$ 90.00	$ 1.32	NA
16	$ 92.40	$ 1.32	$ 1.63
18	$ 97.20	$ 1.32	$ 1.63
20	$ 102.00	$ 1.32	$ 1.63
21	$ 103.20	$ 1.32	$ 1.63
24	$ 120.00	$ 1.32	$ 1.63
26	$ 140.40	$ 1.44	$ 2.12
27	$ 150.00	$ 1.50	$ 2.36
28	$ 160.80	$ 1.56	$ 2.60
30	$ 180.00	$ 1.90	$ 3.11
32	$ 192.00	$ 1.90	$ 5.40
36	$ 204.00	$ 1.90	$ 10.02
38	$ 456.00	$ 2.40	$ 12.36
40	$ 480.00	$ 3.00	$ 14.63
42	$ 504.00	$ 3.79	$ 16.94
43	$ 516.00	$ 3.79	$ 17.22
44	$ 528.00	$ 3.79	$ 17.48
48	$ 576.00	$ 3.79	$ 18.58
54	$ 648.00	$ 3.79	$ 22.93
60	$ 720.00	$ 3.79	$ 27.48

Table 2 Replacement Costs using Open Cut ($ per LF)			
Open Cut Construction			
Pipe Size (in)	0-16 ft depth (assume 8 ft avg depth of cut)	Pipe Size (in)	>16 ft depth (assume 23 ft avg depth of cut)
4	$ 193.00	4	$ 318.00
6	$ 193.00	6	$ 318.00
8	$ 193.00	8	$ 318.00
10	$ 204.00	10	$ 335.00
12	$ 226.00	12	$ 371.00
14	$ 246.00	14	$ 397.00
15	$ 256.00	15	$ 410.00
16	$ 264.00	16	$ 420.33
18	$ 278.00	18	$ 441.00
20	$ 231.00	20	$ 467.67
21	$ 307.00	21	$ 481.00
24	$ 338.00	24	$ 524.00
26	$ 354.67	26	$ 548.00
27	$ 363.00	27	$ 560.00
28	$ 377.67	28	$ 579.67
30	$ 407.00	30	$ 619.00
32	$ 429.33	32	$ 648.67
36	$ 474.00	36	$ 708.00
38	$ 492.67	38	$ 733.67
40	$ 511.33	40	$ 759.33
42	$ 530.00	42	$ 785.00
43	$ 547.67	43	$ 806.83
44	$ 567.33	44	$ 828.67
48	$ 636.00	48	$ 916.00
54	$ 764.00	54	$ 1,080.00
60	$ 886.00	60	$ 1,220.00
66	$ 1,000.67	66	$ 1,355.00
72	$ 1,100.00	72	$ 1,490.00
78	$ 1,230.00	78	$ 1,650.00
84	$ 1,396.00	84	$ 1,838.00
90	$ 1,512.33	90	$ 1,969.00
96	$ 1,610.00	96	$ 2,100.00
102	$ 1,745.00	102	$ 2,255.00
108	$ 1,880.00	108	$ 2,410.00
120	$ 2,250.00	120	$ 2,810.00
144	$ 2,930.00	144	$ 3,580.00

SEATTLE PUBLIC UTILITIES
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APPENDIX D
METHODOLOGY USED FOR ESTIMATING SERVICE LEVEL COSTS FOR SEWER BACKUPS AND DRAINAGE IN COMBINED SEWER AREAS

Appendix D

Methodology for Estimating Costs and Benefits of Achieving Service Levels for Sewer Backups and Drainage in Combined Sewer Areas

This appendix describes the methodology used for estimating the costs and benefits of achieving service levels for sewer backups and drainage in combined sewer areas. Four different service levels were analyzed:

> *SPU customers should be served so that, on average, they do not experience a sewer backup (or surface flooding) due to a problem with the SPU sewer more frequently than:*
>
> - *Once every 2 years*
> - *Once every 5 years*
> - *Once every 10 years*
> - *Once every 20 years*

Relationship Between Sewer Backup Frequency and Surface Drainage Service Levels in Combined Sewer Areas.

The 2004 *Comprehensive Drainage Plan's* drainage service level for areas with separate sewers or partially separated sewers is as follows:

- Manage stormwater runoff within the public right-of-way to protect public safety and buildings (e.g., residences and businesses) from flooding, up to and including runoff from the 25-year, 24-hour design storm event.

- Manage stormwater runoff within the public right-of-way to allow access to and functionality of critical services such as hospitals, fire stations, and schools, up to and including runoff from the 100-year, 24-hour storm.

The 2004 *Comprehensive Drainage Plan* did not establish a service level for the combined sewer areas that comprise most of the SPU service area. This *Wastewater Systems Plan* recognizes that street flooding and basement flooding are related. Seattle's sewer system has adequate catch basins to allow surface drainage to enter the sewer, and street flooding, if it occurs, results from a sewer main blockage or lack of sewer main capacity, just as with basement backups.

In most parts of the SPU service area, streets are higher in elevation than the basements of the adjoining properties. As sewer flows increase and water begins to rise above the top of sewer main into manholes and storm connections, backups into basements will occur before wastewater spills out onto adjacent streets. Therefore, once SPU has established and achieved a service level for sewer backups,that same service level will limit the potential for surface flooding, and a separate service level for surface drainage in combined sewer areas is not needed.

In certain select combined sewer areas of Seattle, there are areas where drainage does not reach catch basins. This is typically due to grading issues which are the responsibility of the Seattle Department of Transportation (SDOT) to correct.

Backup Frequency and Drainage Service Level Options

Backups and/or surface flooding in combined sewer areas can result from missed maintenance, a high intensity storm that overwhelms the capacity of the sewer, or a sewer or pump station failure. From the customer's perspective, however, the cause of the backup is not important. For SPU customers, the primary issue is the frequency of the backup, not the cause. As a result, service level options evaluated were each based on a different frequency, as follows:

SPU customers should be served so that, on average, they do not experience a sewer backup (or surface flooding) due to a problem with the SPU sewer more frequently than:

- *Once every 2 years*
- *Once every 5 years*
- *Once every 10 years*
- *Once every 20 years*

SPU's *Comprehensive Drainage Plan* specified drainage service levels associated with 25-year and 10-year storm frequencies, the highest service level considered in this *Wastewater Systems Plan* was once in 20 years. The costs of achieving a 20-year service level appeared to far exceed the benefits, and therefore higher service levels were not evaluated.

Costs to Achieve Service Level Options

The costs of achieving the service level options listed above are based on the following elements:

- The cost of implementing a maintenance program that ensures that multiple maintenance-related backups or drainage problems on the same pipe segment do not occur.

- The cost of pipe repair and replacement (R&R) program to ensure that sewer or pump-station failure-related backup or drainage problem do not occur.

- The cost of increasing the capacity of pipe segments with capacity deficiencies.

The costs of implementing the maintenance and R&R programs were determined to be identical for all four service level options. SPU's maintenance strategy for pipes requires that once a maintenance-related backup occurs, the reach of sewer will be placed on a scheduled maintenance cycle to ensure that the same backup does not recur. In the case of the R&R program, once a sewer failure occurs leading to a backup, the sewer will be repaired and/or replaced and subsequently inspected, thereby assuring that another sewer failure-related backup does not occur again in a 20-year cycle. Because the cost of the maintenance and R&R program are the same for all level of service options, the cost of replacing capacity-deficient pipes is the primary cost variable among the options.

Capacity issues arise as a result of storm flows, and bigger storms recur less frequently than smaller storms. The costs of achieving each service level option varies according to the number of capacity-deficient pipes and the costs for enlarging or paralleling those pipes. Flows from a 20-year storm are greater than flow from a 10-year storm, and selecting a service level based on a less frequent storm results in a larger number of undersized pipes that need to be replaced. In addition, cost of installing pipe tends to increase with the diameter of the pipe, thereby further increasing the capital costs of achieving a higher service level. Table C-1 summarizes the service level options and their associated costs.

Table C-1. Total Costs of Backup Frequency Service Level Options

Service Level Options Customers in all areas of the City should be served so that on average they do not experience a sewer backup due to a problem with an SPU sewer more frequently than:	**Maximum Cost Above Do-Nothing Alternative**
Once in 2 years	$23.9 million
Once in 5 years	$36.9 million
Once in 10 years	$46.8 million
Once in 20 years	$59.1 million

[a] Methodology for estimating costs is described in Appendix C.

While the costs of achieving higher service levels (i.e., less frequent backups) increase rapidly with the level of service, the customer benefits of higher service levels increase more slowly. That is because the degree to which customers benefit diminishes as the service level rises. The following situations illustrate the diminishing returns associated with moving to higher service levels.

- For a customer that is receiving a once-in-2-year service level, improving the service level to one backup in 5 years will provide a benefit to that customer one or two times every 5 years and about six times over 20 years.

- A customer receiving a service level such that one backup occurs every 10 years will derive the benefit from moving up to a a once-in-20-year service level only one time over that same 20–year period.

Simply stated, there is a point at which obtaining a higher level of service is not worth the additional cost. SPU compared the costs and benefits associated with each service level to arrive at an optimum service level for sewer backups.

Net Present Value Comparisons of Backup Service Level Options

"Net present value" is an economic term referring to the present value or worth of a project or program that has both current and future costs and benefits. All future costs and the value of future benefits are discounted on the theory that a $1,000 cost (or a $1,000 benefit) is less costly (or valuable) if it is deferred to next year than if it is imposed (or bestowed) today. This cost savings (or value reduction) is computed by applying a discount rate to the cost or benefit value. The discount rate used will generally be related to prevailing interest rates at the time the analysis is performed.

In developing net present values, SPU looks beyond economic costs and benefits to its triple bottom line. A triple-bottom-line analysis considers economic, social/political, and environmental costs and benefits. Calculating the economic costs is a straightforward process, but to calculate social/political and environmental costs and benefits requires additional information and assumptions. SPU made the certain assumptions to calculate the benefits to SPU customers of an increased level of service for street flooding, a customer benefit of a higher level of service for sewer backups. Those assumptions were as follows:

- Surface flooding only causes traffic delays when it occurs on an arterial road.
- All cars on arterials are delayed by 2 minutes because of surface flooding.
- The cost of a delay is $25 per vehicle per hour.
- Avoided cost of backup claims (approximately $13,500 per claim).
- Avoided social costs (varies, as described below).
- Avoided regulatory costs (approximately $1,000 per backup).

Information from the Seattle Department of Transportation (SDOT) regarding traffic volumes on arterial streets was combined with the location of sewer pipes that were identified by the hydraulic analysis described in Chapter 6 to have inadequate capacity. The dollar benefits of reducing the storm-related traffic delays in combined areas were calculated assuming that the traffic benefits would be experienced as frequently as the design storm being achieved by the pipeline. For example, if a sewer was identified as not achieving the 10-year service level, then the traffic benefit of achieving the 10-year service level would be experienced at least once every 10 years. The results of SDOT's drainage service level benefit calculations are presented in Table C-2.

Table C-2. Benefits of Drainage Service Level Options

Service Level Options Customers in all areas of the City should be served so that on average the public right-of-way does not experience surface flooding in combined sewer areas due to a problem with the SPU sewer more frequently than:	**Present Value of Drainage Benefits ($)**
Once in 2 years	$ 6.5 million

Once in 5 years	$ 9.5 million
Once in 10 years	$ 9.9 million
Once in 20 years	$ 10.3 million

The number of backups avoided at each service level was determined based on the hydraulic analysis described in Appendix B. It was assumed that each sewer segment with a capacity deficiency would lead to one sewer backup. The frequency of the backups avoided was based on the storm design frequency. In other words, if there were two sewer segments that were deficient during a 5-year storm, then it was assumed that two backups would be avoided every 5 years if the 5-year service level was selected.

Due to the subjective nature of determining a social cost per backup avoided, certain assumptions were made, and a range of values was tested. For capacity project in the Madison Valley, the social costs avoided were calculated to be approximately $96,000 per backup, based on the estimated capital cost of the project and the number of backups avoided per year. $96,000 was considered a high social cost for a backup.

The results of the net present value analysis are presented in Table C-3. The table shows the net present values for the various service levels using a range of social costs. The table shows that assuming social costs of $96,000 per backup, the 2-year, 5-year, and 10-year service levels produce a positive net present value. The 2-year and 5-year service levels achieve a positive net present value when the social costs reach approximately $38,000 and $56,000 per backup, respectively. The 10-year and 20-year service levels reac1h positive net present values at social costs of $77,000 and $106,000 per backup, respectively. The net present value analysis of triple-bottom-line costs and benefits indicated that only when social costs of $35,000 or more per backup is the 2-year service level justified.

Table C-3. Impact of Varying Social Cost and Service Level on Net Present Value

Social Cost per Backup	2-year level of service	5-year level of service	10-year level of service	20-year level of service
$3,000	- $8 m	- $14 m	- $21 m	-$30 m
$40,000	**$0.7 m**	- $4.1 m	- $10.4 m	- $19.1 m
$60,000	**$5.1 m**	**$1.1 m**	- $4.8 m	- $13.3 m
$80,000	**$9.5 m**	**$6.4 m**	**$0.8 m**	- $7.5 m
$110,000	**$16.1 m**	**$14.3 m**	**$9.3 m**	**$1.2 m**

SEATTLE PUBLIC UTILITIES
WASTEWATER SYSTEMS PLAN

APPENDIX E
CUSTOMER SURVEY RESULTS

Seattle Public Utilities Sewer Study

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December, 2005

SPU Sewer Study
December, 2005

Objectives

The goals of this research were to

- guide the development of Seattle Public Utilities' (SPU) Wastewater Systems Plan by gathering information on customer's attitudes about mainline sewer backup service levels.

- assess customers' willingness to pay an additional monthly amount to ensure that sewer backups occur less than once every ten years for all households in the City.

- determine the reasonable amount of time for restoring service to a customer's home in the event of a back-up in the main line

- gain an indication of the relative importance of frequency of occurrence vs. response time

Method

- Phone survey of 354 SPU customers
- Margin of error = 5.21%

Respondent Profile

- Gender: 56% of respondents were female, 44% were male.
- Geography: 48% lived in the Northeast and Northwest sections of the city, 28% lived in the Southeast or Southwest sections, 11% reported they lived in the West, and 13% in the East.
- Own vs. Rent: 92% of respondents owned their residence.
- Household Size: 41% live in two person households, while 24% live in a single person household.
- Race: Three in four (76%) respondents are white/Caucasian.
- Income: 14% of respondents have household incomes of less than $35,000. 62% reported incomes of $35,000 or more. 24% refused to answer the income question.

Willingness to Pay

Respondents were asked a series of yes/no (dichotomous choice) questions to determine their willingness to incur an additional monthly expense to ensure that all households in the City receive the same level of service – a maximum of one backup every ten years.

To provide a relevant and realistic context for these questions, respondents were informed that the average monthly cost for sewer service is $35.15 and were asked to assume that this average cost accurately reflected their monthly cost for sewer service.

Table 1
Stated Willingness to Pay

	All Respondents N =354		**Respondents Willing to Pay N=206**	
	%	**$**	**%**	**$**
Mean (Average)	2.39	0.84	4.11	1.44
Median	1.00	0.35	4.00	1.40

We recommend demand forecasting be based on the median value, as the mean is susceptible to extreme values.

Respondents Unwilling to Pay

42% of respondents were unwilling to incur any additional monthly expense. The primary reasons mentioned for not being willing to incur any additional expense were

- “Haven’t experienced the problem”
- “Unwilling to pay for others”
- “Already pay too much”

Persuading a portion of these respondents to support the subsidy is the challenge for SPU’s marketing communications.

Respondents Willing to Pay

Conversely, the following reasons were cited by respondents who were willing to incur an additional sewer expense

- “It’s a small amount”
- “It’s for the common good”
- “Would reduce backup occurrence”

For those who were willing to incur an additional expense, we asked a follow-up question to evaluate their continued willingness to pay in light of increases in sewer costs likely to exceed the pace of inflation. We asked the respondent to assume that, on average, each household's monthly cost will increase 5% or about $2.13 each year for the next 20 years.

Given these increases, three in four respondents (75%) would still be willing to pay the additional amount. Experience suggests this estimate is overstated. When forecasting demand, a more conservative estimate should be used.

Response Time

We asked respondents what they thought was a reasonable amount of time for restoring service to their home, where time is defined from the moment the City is notified of the problem to the time that the customer is able to use their plumbing.

Respondents were fairly evenly distributed across the time ranges. 12% of respondents stated a reasonable amount of time would be 2 hours or less, 20% indicated between 2 and 4 hours was reasonable, 19% mentioned between 4 and 6 hours was reasonable, 16% indicated between 6 and 8 hours was reasonable, and 23% reported that more than 8 hours was reasonable. 10% of respondents were unsure.

Experience with Back-ups

29% of respondents reported they have experienced a sewer back-up, regardless of the source. Of those who have experienced a back-up, 16% stated the source of the backup was the main sewer line. 49% believed it was the side sewer on their property, and 21% reported that the interior plumbing was the source of the problem. 15% were unsure.

In terms of when the backup occurred, respondents were evenly distributed across the time categories, with 31% stating the backup occurred within the past year, 35% stated it occurred between 1 and 3 years ago, while the remainder indicated it occurred more than 3 years ago.

A number of additional analyses were performed to determine if those who experienced a backup differed significantly from those who had not experienced a backup. The results indicated that those who had experienced a backup were more likely to

- have more children under the age of 18 living in the household
- live in the Northeast and West areas of the city

Additional tests were run to determine if those who experienced a backup would be willing to pay more than those who had not experienced a backup. They were not.

Attribute Importance: Frequency of Occurrence vs. Response Time

We asked respondents to provide an indication of their preference by allocating 10 points between frequency of occurrence and response time. There was a slight preference for response time. Response time was assigned, on average, 5.4 points, while frequency of occurrence was assigned 4.6 points.

Seattle Public Utilities
Sewer Survey
Final November 21, 2005

Screeners

INTRO Hello, this is [Interviewer First Name] with [Data Collection Company Name], calling on behalf of Seattle Public Utilities. We are conducting a study and would like to include the opinions of your household. I want to assure you that we are not selling any type of product or service. This call may be monitored or recorded for quality control purposes.

[PRESS ANY KEY TO CONTINUE]

[AS NEEDED: Let me assure you this is not a sales call, and all the information you give will be kept strictly confidential**]**

[AS NEEDED: This survey will last approximately 10 to 12 minutes.**]**

[AS NEEDED: This survey will provide important information for Seattle Public Utilities. Your participation is important, as you will represent a number of households like yours.**]**

PROGRAMMING NOTE: RANDOMLY ASK FOR MALES 2 TIMES OUT OF 3 IN SCR1.

SCR1 **[FOR MALE]** To ensure that this survey is representative of the City's population, I need to speak with the male in your household who is 18 years of age or older and who had the most recent birthday.

Would that be you?

[FOR ADULT] For this survey, I need to speak to an adult in your household who is 18 years of age or older and who had the most recent birthday. Would that be you?

[IF ASK FOR MALE AND HH IS FEMALE ONLY, THEN ASK FOR FEMALE HEAD OF HOUSEHOLD
IF MORE THAN ONE MALE, THEN ASK FOR MALE WITH LAST BIRTHDAY]

1 RESPONDENT AVAILABLE
2 RESPONDENT NOT AVAILABLE **[CTRL-END, SCHEDULE CALLBACK, DISPO =11]**
3 NO ONE IN HOUSEHOLD IS 18 OR OLDER **[SKIP TO TKAGE, DISPO = 22]**
4 LANGUAGE BARRIER **[SKIP TO TKLANG, DISPO = 17]**
8 DON'T KNOW / REFUSED **[SKIP TO THANK9. DISPO=8]**

S1 What is your home zip code?

_____ ENTER ZIP CODE
99999 DON'T KNOW / REFUSED

SCR1A [IF SCR1 = 9999] Is your home zip code [ZIP CODE FROM SAMPLE]?

1 YES **[SKIP TO S2]**
2 NO
9 DON'T KNOW / REFUSED **[[SKIP TO THANK9]** [DISPOSITION = 8]

S2 To verify, the zip code I entered was [SHOW ZIP CODE ENTERED IN S1]. Is this correct?

1 YES
2 NO [SKIP TO S1]
9 DON'T KNOW / REFUSED **[SKIP TO THANK9]** [DISPOSITION = 8]

[IF ZIP CODE NOT IN CITY OF SEATTLE SKIP TO THANK1] [DISPOSITION = 23]

S3 [IF ZIP CODE = 98133 OR 98177] Do you live North or South of 145th Street?

[IF NECESSARY, PROBE: 'North or South of the Seattle Golf and Country Club?]

1 NORTH OF 145TH STREET **[SKIP TO THANK1]** [DISPOSITION = 23]
2 SOUTH OF 145TH STREET
9 DON'T KNOW / REFUSED **[SKIP TO THANK9]** [DISPOSITION = 8]

S4 Do you live East or West of Interstate 5?

1 EAST
2 WEST
9 DON'T KNOW / REFUSED **[SKIP TO THANK9]** [DISPOSITION = 8]

S5 [IF ZIP CODE = 98144] Do you live North or South of Interstate 90?

1 NORTH
2 SOUTH
9 DON'T KNOW / REFUSED **[SKIP TO THANK9]** [DISPOSITION = 8]

PROGRAMMER NOTE: GEO SOURCE IS ZIPCODE LIST BY AREA

GEO GEOGRAPHIC AREA

1 NORTHWEST
2 NORTHEAST
3 WEST
4 EAST
5 SOUTHWEST
6 SOUTHEAST

GENDER

1 MALE
2 FEMALE

S6 Which of the following best describes your home? Is it a…

1 Duplex or Two Family House, [THANK8, DISPO = 26]
2 Apartment or Condominium in Building with Two to Four Units, [THANK8, DISPO = 26]
3 Apartment or Condominium in Building with Five or More Units, [THANK8, DISPO = 26]
4 Single Family House?
5 OTHER [SPECIFY] [THANK8, DISPO = 26]
9 REFUSED

S7 Do you own or rent the place in which you live?

1 OWN
2 RENT
9 REFUSED [THANK9, DISPO = 8]

S8 [ASK IF S7=2] Does your household receive a water and / or sewer bill from Seattle Public Utilities or Seattle Public Utilities / the City of Seattle?

1 YES
2 NO [THANK8, DISPO = 28]
8 DON'T KNOW [THANK9, DISPO = 8]
9 REFUSED [THANK9, DISPO = 8]

S9 Are you the person in your household who normally pays the utility bill?

1 YES [SKIPTO A1]
2 NO
8 DON'T KNOW [THANK9, DISPO = 8]
9 REFUSED [THANK9, DISPO = 8]

S10 May I speak to the person in your household who normally pays the utility bill?

1 YES
2 NO [THANK9, DISPO = 8]
9 DON'T KNOW / REFUSED [THANK9, DISPO = 8]

S11 Hello, this is [Interviewer First Name] with [Data Collection Company Name], calling on behalf of Seattle Public Utilities. We are conducting a study and would like to include the opinions of your household. I want to assure you that we are not selling any type of product or service. This call may be monitored or recorded for quality control purposes.

[PRESS ANY KEY TO CONTINUE]

SEWER MAIN LINE BACKUPS

SWINTRO Homeowners can have problems with their toilets or sinks backing up. The source of the problem could be the plumbing inside the home, the side sewer on the property, or the main line that carries the sewage away from the home. The homeowner is responsible for any backup resulting from the interior plumbing or the side sewer. The City/Seattle Public Utilities is responsible for any problems with the main sewer line.

A1 Have you ever experienced a sewer backup ?

1	YES	
2	NO	SKIP TO NEXT SECTION CVINTRO
9	NOT SURE	SKIP TO NEXT SECTION CVINTRO

A2. How long ago did this backup occur? Would that be ….

1. Less than 1 yr ago,
2. Between 1 and 3 years ago, or
3. More than 3 years ago
9. NOT SURE

A3. What was the source of the backup? Would that be …

1 Main Sewer Line
2 Side Sewer on your Property, or
3 Interior Plumbing
9 NOT SURE

CONTINGENT VALUATION

CVINTRO

In this section, we will ***focus on sewer backups due to problems with the main line, the portion of the water system the City/Seattle Public Utilities is responsible for***. These backups occur because of blockages to the line, pipe failure, or pipes that are undersized. Households have different experiences with respect to these kinds of backups. Currently, the vast majority - 96% - of the homes in the city experience a backup less than once every 20 years. A small percentage of homes experience backups more than once every five years.

In order to manage public funds more effectively, Seattle Public Utilities would like to know if you would be willing to pay an additional monthly amount to ensure that sewer backups occur less than once every ten years for ALL households in the City. In other words, ALL households in the city would receive the same level of service – a maximum of one backup every ten years.

Most homeowners receive a combined utility bill once every two months that covers the cost of their water, sewer and garbage service. However, in this next set of questions, we want to ***focus on the monthly cost for sewer services***. To help you assess the dollar impact of any potential additional expense for sewer service, keep in mind that the ***average monthly cost for sewer service is $35.15***. For the purposes of this survey, assume that this average cost accurately reflects the amount you pay. In other words, your monthly cost for sewer service is approximately $35.

F1 To ensure that ALL households in the City receive the same level of service – a maximum of one backup every ten years – would you be willing to pay an additional 3% (approximately $1) per month for sewer service?

1 YES
2 NO [SKIP TO QF5]
3 NOT SURE [SKIP TO QF5]

F2 Would you be willing to pay an additional 5% (approximately $1.75) per month?

1 YES
2 NO [SKIP TO QF4]
3 NOT SURE [SKIP TO QF8]

F3 Is there an amount greater than 5% (approximately $1.75) that you would be willing to pay?

1 YES [RECORD AMOUNT GREATER THAN $1.75 $________SKIP TO QF8]
2 NO [SKIP TO QF8]
3 NOT SURE [SKIP TO QF8]

F4 Would you be willing to pay an additional 4% (approximately $1.40) per month?

1 YES [SKIP TO QF8]
2 NO [SKIP TO QF8]
3 NOT SURE [SKIP TO QF8]

F5 Would you be willing to pay an additional 1% (approximately 35 cents) per month?

1 YES
2 NO [SKIP TO QF7]
3 NOT SURE [SKIP TO QF7]

F6 Would you be willing to pay an additional 2% (approximately 70 cents) per month?
1 YES [SKIP TO QF8]
2 NO [SKIP TO QF8]
3 NOT SURE [SKIP TO QF8]

F7 Is there an amount less than 1% that you would be willing to pay?

1 YES [RECORD AMOUNT LESS THAN 35 CENTS: $________ASK QF8]
2 NO [SKIP TO QF9]
3 NOT SURE [SKIP TO QF9]

F8 Why are you willing to incur this additional monthly expense?

[OPENEND QUESTION. RECORD VERBATIM]

F9 Why are you NOT willing to incur this additional monthly expense?

[OPENEND QUESTION. RECORD VERBATIM]

PROGRAMMER NOTE: IF RESPONDENT ANSWERS F9, SKIP TO RESPONSE TIME QUESTION R1

F10 Over the next several years, Seattle Public Utilities expects each household's sewer bill to increase at a faster rate than inflation, primarily due to increased treatment costs paid to King County. I am interested in knowing whether you would still be willing to pay an additional amount to improve service in light of these increases. The exact amount of the increase is not known, but for the purposes of this survey assume that on average each household's monthly cost will increase 5% or about $2.13 each year for the next 20 years. Given these increases would you still be willing to pay the additional amount to ensure that ALL households in the City receive the same level of service - a maximum of one backup every ten years?

1 YES
2 NO
3 NOT SURE

RESPONSE TIME

R1 Now we would like to know your opinion about the time it should take for the City to restore service to your home in the event of a backup in a sewer mainline. If the backup is due to a blockage in a pipe or a pipe failure, what do you think is a reasonable amount of time for restoring service to your home, where the time is from the moment the City is notified of the problem to the time that you are able to use your plumbing?

1 2 hours or less,
2 Between 2 and 4 hours,
3 Between 4 and 6 hours,
4 Between 6 and 8 hours, or
5 More than 8 hours
6 NOT SURE

ATTRIBUTE IMPORTANCE

ATINT With respect to sewer backups resulting from problems with the main sewer line, we have asked for your opinions on two factors: how frequently backups occur and response time.

In order to help Seattle Public Utilities allocate their resources better, I'd like you to distribute 10 points between these two factors to reflect their relative importance to you. You may give anywhere from 0 to 10 points to each factor, as long as the point total adds up to 10. Should I read that again?

PROGRAM TO ACCEPT WHOLE NUMBERS ONLY
INTERVIEWER: ACCEPT WHOLE NUMBERS ONLY; NO FRACTIONS.
ROTATE AT1 & AT2

AT1 How many points would you assign to …?
Frequency of occurrence ENTER NUMBER _______________

AT2 [How many points would you assign to …?]
Response time ENTER NUMBER _______________

TOTAL 10

[IF NOT ADD UP TO 10, REASK]

DEMOGRAPHICS

D6 How long have you lived in the City of Seattle?

[ENTER 0 FOR LESS THAN ONE YEAR]

__ ENTER YEARS
99 REFUSED

D7 Including yourself, how many people live in your household?

__ ENTER NUMBER IN HOUSEHOLD
99 REFUSED

D8 How many children under the age of eighteen live in your household?

[BASE = RESPONDENTS WITH MORE THAN 1 HOUSEHOLD MEMBER (H8 > 1)]

__ ENTER NUMBER OF CHILDREN
99 REFUSED

D9 What is your age?

__ ENTER AGE
99 REFUSED

D10 Are you between?

[BASE = RESPONDENTS WHO REFUSED AGE (D9 = 99)]

1 18 to 25,
2 26 to 35,
3 36 to 50,
4 51 to 64, or
5 65 years of age or older?
9 REFUSED

D11 Are you Spanish, Hispanic, or Latino?

[PROBE: Were your ancestors Mexican, Puerto Rican, Cuban, Central or South American, or from Spain?]

1 YES
2 NO
8 DON'T KNOW
9 REFUSED

D12 [IF D11 <>1] I am going to read a list of race categories. Please choose one or more races you consider yourself to be:

[IF D11 = 1] Given that you are Spanish, Hispanic, or Latino, how would you best describe your race?

[CLARIFY "INDIAN" WITH "Is that American Indian or Asian Indian?"]

[ASIAN/PACIFIC ISLANDER INCLUDES GROUPS SUCH AS: CHINESE, FILIPINO, HAWAIIAN, INDIAN (ASIAN), VIETNAMESE, KOREAN, JAPANESE, CAMBODIAN, AND SAMOAN.]

["Hispanic" SHOULD BE TALLIED "Some other race"]

[READ LIST]

1 White or Caucasian
2 Black or African American
3 American Indian or Alaskan Native
4 Asian or Pacific Islander
5 Some Other Race **[SPECIFY:_____________]**
8 Don't know
9 REFUSED

D13 [IF D12.2 > 0] Is there any race you identify with the most? [IF YES] Which one?

[SHOW ONLY THOSE SELECTED IN H21]

1 WHITE OR CAUCASIAN
2 BLACK OR AFRICAN AMERICAN
3 AMERICAN INDIAN OR ALASKAN NATIVE
4 ASIAN OR PACIFIC ISLANDER
5 SOME OTHER RACE **[SPECIFY:]**
98 NONE – MULTI- / BI-RACIAL
99 DON'T KNOW / REFUSED

D14 What is the primary language spoken at your home?

1 ENGLISH
2 SPANISH
3 OTHER **[SPECIFY]**
4 REFUSED

D15 Finally, is your total household income above or below $35,000 a year?

1 BELOW $35,000
2 $35,000 AND ABOVE
9 REFUSED

D15A Would that be…

<u>[RESPONDENTS BELOW $35,000 (D15 = 1)]</u>

1 Less than $7,500,
2 $7,500 to $15,000
3 $15,000 to $25,000, or
4 $25,000 to $35,000?
9 REFUSED

D15B Would that be…

<u>[RESPONDENTS ABOVE $35,000 (D15= 2)]</u>

1 $35,000 to $50,000,
2 $50,000 to $75,000,
3 $75,000 to $100,000, or
4 $100,000 or over?
9 REFUSED

D16 We are conducting a follow-up study as part of this research project. Would you be interested in participating?

1 Yes
2 No [SKIPTO THANK]

D17 In order to contact you for a follow-up study, may I have your ….?

Name:

Address:

Phone:

Email address:

THANK

THANK Thank you very much for your time. Have a good evening / afternoon.
[PRESS ANY KEY TO CONTINUE]

THANK1 Thank you for your time, but we today we are interviewing residences located within the City of Seattle boundaries.
[PRESS ANY KEY TO CONTINUE]

THANK8 Thank you for your time. That's all questions I have. Have a nice day/evening.
[PRESS ANY KEY TO CONTINUE]

THANK9 Thank you for your time, but we cannot continue without that information.
[PRESS ANY KEY TO CONTINUE]

SEATTLE PUBLIC UTILITIES
WASTEWATER SYSTEMS PLAN

APPENDIX F
GRAVITY SEWER MAINTENANCE OPTIONS

O&M Proposal - Drainage and Wastewater
Mainline Maintenance Strategy

Introduction

Seattle Public Utilities (SPU) currently responds to an average of 600-800 calls per year concerning sewer backups. The number of calls fluctuates significantly from year to year depending on several conditions; most notably the quantity, intensity, and duration of seasonal rain events. The overwhelming majority of reported sewer backups result in a backup characterized by a residential basement flooded with sewage due to a clogged or broken sewer pipe.

Drainage and wastewater field crews are typically dispatched to a site shortly after a sewer backup complaint is received. Approximately 90% of all complaints result in the finding that the sewer backup has been caused by problems associated with a private side sewer (often root intrusion into the complainant's side sewer resulting in a backup event) and are therefore deemed not to be the responsibility of SPU. When a private side sewer is found by the field crew to be clogged the homeowner is informed of the likely cause and given a referral list of contractors capable of removing the blockage and/or repairing the pipe.

The remaining 10% of complaints (approximately 80 per year) are caused by problems associated with an SPU sewer mainline. Table 1 below shows the typical breakdown by percentage of each type of these backups:

Mainline Sewer Backup Cause	Typical Percent of Total Sewer Backups
Storm Overload	25%
Roots	25%
Grease	25%
Debris	15%
Other*	10%

*Third party damage, pump station failure, structural pipe failure, or unknown cause

Table 1 – Causes of SPU Mainline Sewer Backups by Percentage

This analysis was undertaken with the goal of finding the most cost effective mainline sewer pipe maintenance strategy for Seattle Public Utilities using triple bottom line costing methods. The analysis assumes costs for fines related to sewer backups but does not rule out non-zero tolerance policies (it in fact endorses cost effectiveness and non-zero tolerance policies) concerning the prevention of "controllable" sewer backups. This is contrary to the current draft SSO NPDES permit language that proposes "0" controllable sewer back ups. See the following sections for further definition.

Current Program Background

The current Mainline Sewer Pipe Maintenance program includes all preventative (proactive) maintenance activities related to the cleaning of sewer and drainage mainlines. There are five field activities that Drainage and Wastewater field crews perform as part of this strategy. Each activity is designed to correct a specific maintenance problem given each mainline's individual characteristics. The table below lists each activity and the primary purpose of each.

Activity	**Mainline Problem**
Jetting	Light to Medium Debris
Rodding	Roots with Active Block
Hydrocutting	Roots and/or Grease
Dragging	Heavy Debris
Chemical Root Treatment (Wastewater Only)	Roots/ No grease present

The primary purpose of the program is to maintain conveyance capacity in sewer and drainage mainlines. The above activities focus on preventing sewer surcharges (back ups) and combined sewer system overflows due to blockages or restrictions in pipes. Current program or service delivery is driven by a combination of both internal and external service levels.

Current Program Drivers (Service Levels)

There are numerous drivers for this group of maintenance activities. The drivers can be department policies and service levels to federal regulations. They can also be formal documents to informal agreements. Below is a summary list of the drivers for these maintenance activities.

Comprehensive Drainage Plan
All drainage services

- Construct, maintain and operate SPU's drainage infrastructure according to asset management principles in order to minimize risks to City property, promote environmental protection, and ensure long-term viability of City assets.

Protection of public safety and property

- Manage storm water runoff within the public right-of-way to protect public safety and buildings (e.g., residences and businesses) from flooding, up to and including runoff from the 25-year, 24-hour design storm event.
- Manage storm water runoff within the public right-of-way to allow access to and functionality of critical services such as hospitals, fire stations, and schools up to and including runoff from the 100-year, 24-hour design storm event.
- Manage storm water runoff within the public right-of-way to protect public safety and support mobility on major transportation routes (i.e., arterial roads) up to and including runoff from the 25-year, 24-hour design storm event.

- Manage storm water runoff within the public right-of-way to protect public safety and support mobility on residential roads (i.e., non-arterial roads) up to and including runoff from the 5-year, 24-hour design storm event.
- Protect drainage system facilities and infrastructure within landslide-prone areas, and mitigate the direct effects of drainage system operations that are contributing to landslide-prone conditions.
- Protect and improve where possible, creek, shoreline, and lake aquatic receiving waters from the direct impacts of SPU's drainage system, using science based projects and programs.
- Provide aggressive pollution prevention programs such as business inspections, source control, and public outreach programs.
- Operate a robust water quality-monitoring program to identify problem areas and evaluate the effectiveness of management decisions in protecting and enhancing aquatic resources.
- Meet National Pollutant Discharge and Elimination System (NPDES) permit requirements for water quality protection, as well as other applicable water resource regulatory requirements.

Combined Sewer Overflow Regulation - WAC Chapter 173-245
WAC 173-245-010 – "Greatest reasonable reduction of combined sewer overflows at the earliest possible date"
WAC 173-245-020 (22) – " 'The greatest reasonable reduction' means control of each CSO such that an average of one untreated discharge may occur per year"

NPDES Waste Discharge Permit #WA-003168-2 (Current CSO permit)
S3.A – OPERATION AND MAINTENANCE – The permittee shall implement operation and maintenance program for the sewer system and all CSO outfalls to reduce the magnitude, frequency and duration of CSO's. The program shall include regular sewer inspections, sewer, catch basin and CSO facility cleaning; ………
S3.E – ELIMINATE DRY WEATHER OVERFLOWS – Dry weather overflows from CSO outfalls are prohibited.

Proposed SSO NPDES
§122.38 (f) Municipal Sanitary Sewer Systems – Prohibition of Discharges. (1) General Prohibition. Municipal sanitary sewer system discharges to waters of the United States that occur prior to a publicly owned treatment works (POTW) treatment facility are prohibited.

§122.38 (g) (1) - Definition of Sanitary Sewer Overflow.
A sanitary sewer overflow (SSO) is an overflow, spill, release, or diversion of wastewater from a sanitary sewer system. SSOs do not include combined sewer overflows (CSOs) or other discharges from the combined portions of a combined sewer system. SSOs include:
(i) Overflows or releases of wastewater that reach waters of the United States;
(ii) Overflows or releases of wastewater that do not reach waters of the United States; and
(iii) Wastewater backups into buildings that are caused by blockages or flow conditions in a sanitary sewer other than a building lateral. Wastewater backups into buildings caused by a blockage or other malfunction of a building lateral that

is privately owned is not an SSO.

AMC 2003 Approved Levels of Service

- Sanitary Sewer Collection System Overflows: Compliance with anticipated sanitary sewer overflow (SSO) NPDES permit. No “controllable” SSOs and enhanced public notification of all SSOs per pending EPA rules
- Combined Sewer Collection Overflows: Compliance with Washington State combined sewer overflow (CSO) regulation. Combined sewer overflows (CSOs) shall be limited to an average of five untreated discharges per CSO site per five years (per National Pollutant Discharge Elimination System (NPDES) permit) by the year 2020.
- Eighty (80) percent of priority 1 problems (emergencies affecting one or many users) are responded to within one hour of notification
- Eighty (80) percent of priority 1 problems (emergencies affecting one or many users) have service reinstated within 4 hours.

Current Practice

DWD currently has an undocumented program in place to address the management of sewer or drainage system blockages. This program has evolved over the years as resources and technologies have changed. The current program uses identified problems as the trigger for creation of preventative maintenance schedules. No preventative maintenance is conducted without previous knowledge of a problem with a mainline. The steps in the process are outlined below.

1. Problem Identification – Field staff receive notification of a problem in the system through various methods.
    - Customer Complaint
    - Proactive structural CCTV inspections (Sewer Risk Model)
    - Flow monitoring data.
2. Investigation/Response – Crew is dispatched to inspect problem and determine cause.
    - CCTV line to determine cause of problem.
    - Clear restriction or blockage using one of the activities described above, preferably rodding.
3. Evaluation – Strategic Operations staff reviews inspection data to determine existing failure cause. There are four possible findings.
    - Structural Defects
    - Maintenance Related defects (remainder of outline addresses this)
    - Possible system capacity issues.
    - No noticeable failure mode
4. Develop corrective action (Maintenance Problems)
    - Review CCTV tape and response crew information.
    - Research maintenance history in work order management system (WMS/IMS) to determine if deterioration is in progress and if so, at what rate.
    - Determine initial preventative maintenance activity based on type of problem founded (roots, debris, grease, etc)
    - Set frequency to prevent future system failures while maximizing return intervals for crews (setting “just in time” schedules).
5. Preventative maintenance work orders are released on a monthly basis to field crews.

10,000 out of a total of 53,000 mainlines are on preventative maintenance schedules based on the above described process. These schedules range in frequency from every three months to 10 years. The majority of these schedules fall in the 1-3 year frequency range. The average annual workload for these activities is 3500 work orders.

Additionally, approximately 50 new mainlines are added to the scheduled workload each year based on the problem response process above. However, this rate of new preventative schedules is not assumed to be constant. As the infrastructure ages, the number of mainlines with maintenance problems will increase. But this increase will only continue until the system deteriorates to the point of rehabilitation. As lines are repaired, relined or replaced, they will be removed from maintenance schedules. A wave rider model is not available for sewer or drainage mainlines yet. Figure 1 below illustrates, in a very general way, this maintenance vs. rehabilitation relationship.

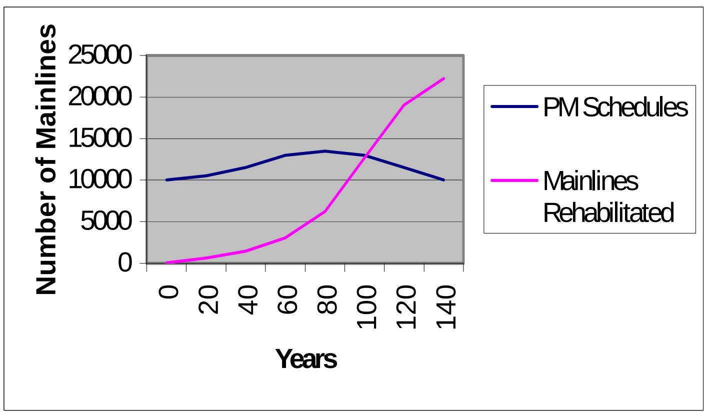


Figure 1: Maintenance vs. Rehabilitation Trends

The average annual production of sewer pipe cleaning maintenance (hydrocutting, rodding, jet cleaning, and chemical root foaming) has averaged approximately 850,000 linear feet (or 9% of all sewer mainlines) from 1997-2004. However, as Figure 2 below indicates, production has trended downward in 2003 and 2004.

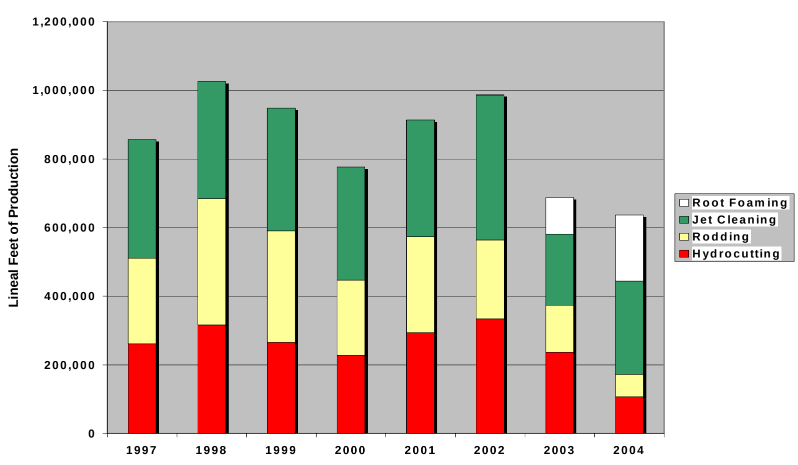


Figure 2 – Total Annual Production for SPU Drainage and Wastewater Pipe Cleaning Activities (1997-2004)

While many issues have been responsible for the overall decrease in production, the primary reason has been an increased emphasis on diverting more resources towards sewer rehabilitation and other activities. Table 1 below details the changes in O&M staff experienced over the last four years and a potential loss for 2006.

Year	Positions	Re-allocation
2001	5	Start 2nd Rehab crew to support building backlog– shift from O&M to CIP
2002	6	03-04 Budget – O&M position requests approved
2004	5	Started 3rd Rehab crew – shift from O&M to CIP
	2	Re-allocated positions to new ORC Function – Positions and funding shifted
	2	Created 4 half time job sharing positions with Watersheds and Landsburg to cover O&M budget reduction
2005	2	Permanent re-assignments for injury/other
	3	Re-Allocated to department wide landscaping function to cover O&M budget reduction.
2006		2 –3 possible pending PDP on creation of new Locating Services for DWD
Total	**15**	

Red=Loss Black=addition

Table 1: Historic Staffing Changes

As resources drop, crews shift from a proactive method of operation to a more heavily reaction driven operation. Reactive operation causes significant inefficiencies in crew utilization through repeated set ups, travel time and other impacts. The current DWD program can not fully support the amount of scheduled maintenance that has been already identified. It is likely that this recent decrease in overall pipe cleaning production has led to the recent increase in sewer backups due to missed maintenance. Figure 2 below shows the increasing trend in back ups due to missed maintenance schedules.

Note: Back ups due to missed maintenance not tracked prior to 2001

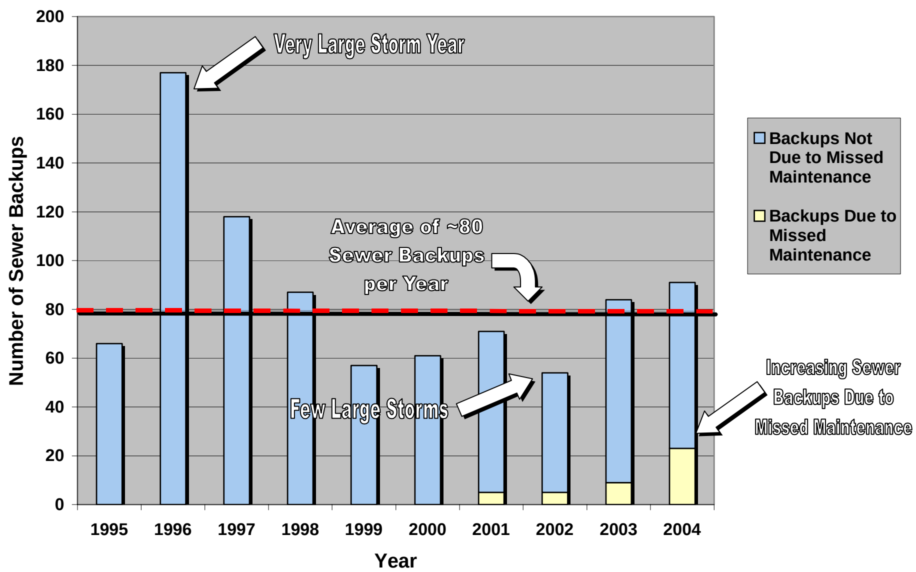


Figure 2 – Annual Mainline Sewer Backups (1995-2004)

Mainline Sewer Pipe Maintenance Strategies Alternatives

As implied in the previous sections, the current program was developed out of necessity rather than formal cost-benefit analysis. This proposal will evaluate five potential future mainline sewer pipe maintenance strategies ranging from purely reactive to purely proactive and including the existing strategy to determine optimal approach.

Strategy A – 100% Reactive

Strategy A would consist of a 100% reactive mainline sewer maintenance. All mainlines currently on preventative maintenance would be removed from the WMS system. Crews would respond to system failures as they occur. The blockage or other issue would be corrected and no further action would be planned.

Due to the purely reactive nature of this approach, it is expected that the annual number of mainline sewer backups would rise substantially from existing conditions. Costs associated with the increase in sewer backups would include high reactive (non-scheduled) maintenance costs for backup relief, high claims costs due to the increased number of claims, high environmental and social costs, and potentially high fines relating to regulatory non-compliance.

Strategy B – Existing Program, Current Performance (Status Quo)

Strategy B is to remain with the current SPU mainline line maintenance strategy detailed previously.

This strategy results in an average of approximately 80 sewer backups per year based on historical data. Costs associated with reactive components of this approach, such as labor and equipment costs for sewer backup relief, claims costs, and environmental and social costs, are much lower than those in Strategy A because many fewer sewer backups are experienced. Likewise, potential fines incurred from violation of existing and future regulations would be much lower than Strategy A but higher than the other strategies analyzed. One consideration not addressed in this report is the increasing trend in back ups due to missed maintenance. This potential trend will result in increased costs over time. Therefore, the costs used to evaluate this option represent 2005 dollars and are not considered sustainable for future projections.

Strategy C – Full Implementation of Current Strategy

Strategy C utilizes a greater degree of proactive maintenance. The current practice would be improved to complete all scheduled work orders on time. It is projected that approximately 55 mainline sewer backups per year would occur on average. The target of 55 backups will be reviewed in the future context of sewer service levels being developed for the SPU drainage comprehensive plan. Additionally, a current pilot project is underway to incorporate customer input in setting service level standards. Costs for items such as labor and equipment for sewer backup relief, claims, environmental and social costs, and potential fines relating to regulatory non-compliance are diminished from those observed in Strategy B. Important elements of this strategy include increased proactive maintenance, efficiency improvements and the associated costs.

Strategy D – Selectively Proactive & Reactive

This strategy further emphasizes proactive means to anticipate and prevent sewer back ups before they occur. This strategy would attempt to prevent future back ups in mainlines located near already identified problem mainlines. Based on historical data, areas that have shown a concentration of mainlines that currently require cleaning would be placed on schedules. Area boundaries and frequencies would be based on the specific known maintenance issue and similar physical characteristics that would contribute to future maintenance issues in adjacent mainlines.

This strategy is estimated to result in an average of 35 mainline sewer backups per year. Costs related to a reactive approach to sewer backups such as labor and equipment for sewer backup relief, claims, environmental and social costs, and potential fines relating to regulatory non-compliance are further reduced from the previously mentioned strategies.

Strategy E – 100% Proactive

This strategy relies as completely as possible on proactive mainline sewer maintenance methods to reduce the number of sewer backups to an absolute minimum. All mainlines in the city would be placed on a minimum maintenance schedule of three years. This three year schedule was selected based on the average frequency of mainlines already on schedules. Some reactive maintenance would still occur.

Gaps to Making a Recommendation

The above alternatives could all be evaluated with respect to costs and benefits given current crew and process performance data. However, further evaluation is needed to determine if current performance is at an acceptable and competitive level. This evaluation can be divided into two categories.

1. Crew Efficiency
2. Process Improvement Potential

This section will discuss each of these categories and the potential improvements that need to be implemented.

1. Crew Efficiency

An important variable for any maintenance strategy is crew productivity (both existing and proposed). The question is, “How competitive is DWD’s performance?” A San Diego benchmarking study was used to compare similar maintenance programs in twelve municipalities. Figure 3 below shows that SPU current performance is either at or above the panel average.

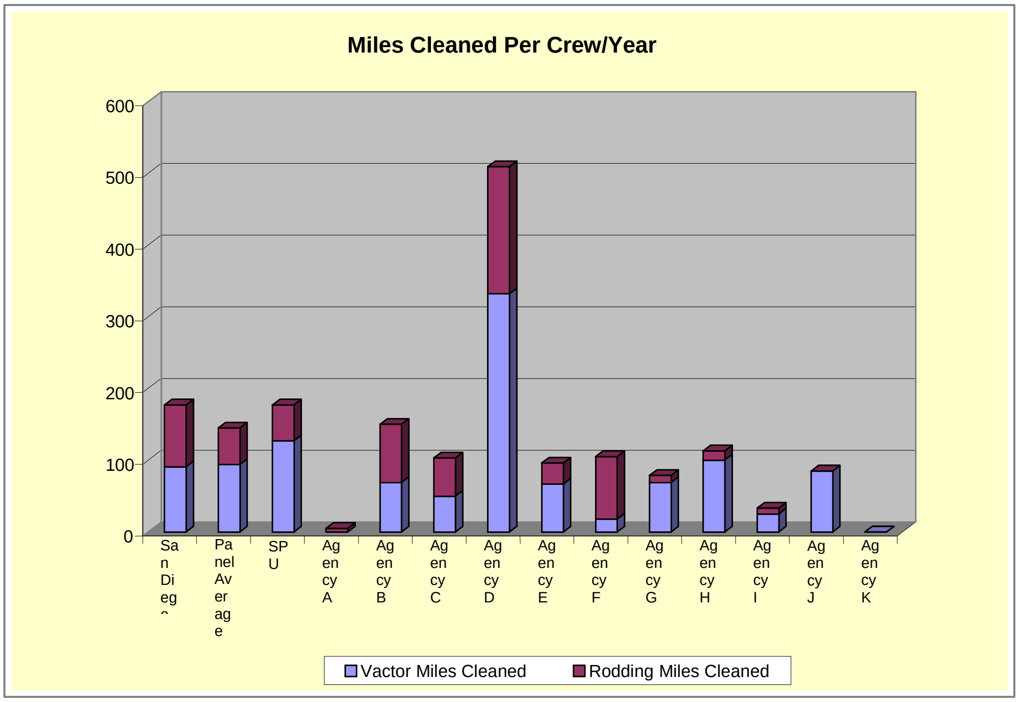


Figure 3: San Diego Benchmarking Results

Figure 4 below shows SPU Drainage and Wastewater crew productivity (1997-2004) for the four primary activities associated with this strategy. It should be noted that “Root Foaming” (the chemical root treatment) was only begun on a large scale during the summer of 2003. Since that time, performance issues have been identified and the program has been put on temporary hold for further refinement.

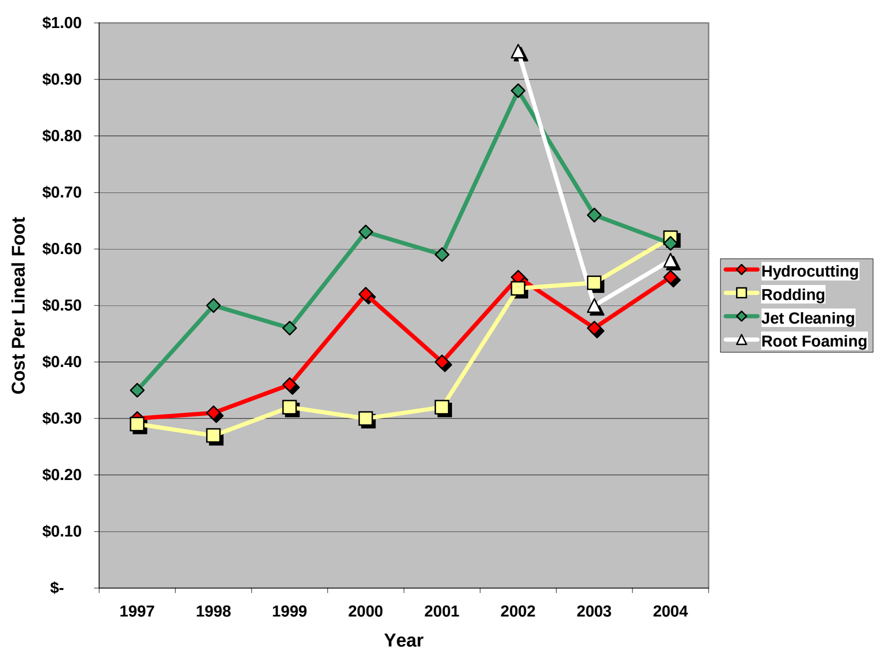


Figure 4: Costs per LF for SPU Drainage and Wastewater Maintenance Activities (1997-2004)

The two sets of data above show there is room for improvement. While DWD crews are reasonably competitive with other cities, SPU costs have been going up. This increase has resulted from several factors detailed in previous sections. For this analysis, a 7% efficiency improvement has been estimated based on the following assumptions.

- Improved work order management to reduce crew travel time
- Creation of 1st Response crew to minimize PM crew disruption

2. Process Improvement Potential

1. Grease Abatement Program

The AMC has recently approved the implementation of a wide-ranging grease abatement strategy that includes the addition of one full-time grease inspector to enforce the City's grease ordinance. This person will be tasked with investigating grease-related "hotspots" and penalizing particularly egregious violators of the ordinance. The inspector would be aided by two existing inspectors (borrowed from SPU's water quality inspection team) serving on an as needed part-time (~25%) basis. It is estimated that the addition of this one full-time grease administrator will reduce the need for grease removal in sewer lines by 50% after one full year of operation. This reduction will result in an estimated 7% reduction in total work orders released to the crews.

2. Calibrating Cleaning Frequencies

Revisiting existing cleaning frequencies and subsequent re-calibration of some of these frequencies has the potential for achieving big gains in efficiency. Historical patterns of completed work orders, growth in back log and resulting back up due to missed maintenance indicate there is some fine tuning of the schedules that can occur. As the figures in the previous sections indicate, the decrease in work accomplished began in 2002. However, it was not until 2004 that an increasing trend in back ups due to missed maintenance materialized. This indicated that there is some factor of error in the frequencies that have been set. This was confirmed in a small study done by Field Operations. CCTV inspections were performed on 100 mainlines immediately prior to their scheduled cleaning. This study found that the majority of the lines were on an appropriate schedule to accomplish a "just in time" cleaning frequency. However, 20-25% of the lines had not reached the condition that warranted cleaning on its current cleaning frequency. Both of these findings indicate re-calibration would be beneficial. Re-calibration, as indicated below, can be achieved in several ways.

Examples of ways to recalibrate existing cleaning cycles could include:

- Waiting for a sewer backup to occur before placing a pipe on a particular cycles (least preferred).
- Reviewing schedule date vs. completion date within the WMS/IMS system to identify possible over scheduling. Historical data in IMS such as previous cleaning cycle's initiation and completion dates can be sufficient indication for schedule adjustments.
- Conduct pre-cleaning inspections using one of two methods
    1. Inspecting the entire pipe length via a conventional remotely controlled CCTV camera at the scheduled cleaning cycle return date. The cleaning cycle could then need to be subsequently re-calibrated based on the inspection results.

2. Inspecting the pipe with a lesser degree of clarity using a stationary zoom camera placed in the upstream or downstream maintenance hole.

For this analysis, it is estimated that the re-calibration of existing schedules will reduce the total work orders released to the crews by 5%.

C. Chemical Root Treatment

The root treatment program was implemented in 2003. Two critical factors resulted in the temporary discontinuance of this program.

DWD had insufficient data on many mainlines to determine if chemical root treatment would be an appropriate preventative maintenance activity. The presence of grease with roots prevents the chemical from adhering as needed to achieve the maximum kill rate. DWD has begun the process of re-evaluating each mainline scheduled for treatment for possible presence of grease.

Additionally, further refinement of the chemical application process is required. The manufacturer recommends two methods for application. Initial treatments are showing that one method is not as effective as first thought.

The results still show good potential for this process in the correct condition. Strategic Operations will continue to refine and re-implement this program. A very conservative 1% reduction in root schedules has been estimated for full implementation of this program.

D. Research New Technologies

A routine part of Strategic Operations (SO) function is to investigate and develop new, more efficient and cost effective methods to achieve the prescribed service levels. SO is currently looking at new equipment and processes for mainline cleaning. While this area is critical, there was no cost efficiency from this activity estimated in this analysis.

Table 2 below summarizes the improvement estimates detailed above.

Assumptions	$
Cost of Option C Without Efficiencies	**$1,597,058**
5% reduction in wo due to schedule review	($51,435)
7% reduction in wo due to grease program	($72,008)
1% reduction in wo due to roots program	($10,287)
7.6% decrease in PM cost/wo due to crew effic's	($68,017)
Cost of grease program (already approved)	$150,000
Scheduling review costs; other effic costs	$100,000
Cost of Option C With Efficiencies	**$1,645,310**

Economic Analysis

Numerous costs, both proactive and reactive in nature, have been summed to provide the overall total cost of each maintenance strategy. For purposes of simplicity each alternative was tied directly to the number of sewer backups expected for a given strategy. This is due to the fact that sewer back ups provide the clearest cause and effect indicator of the effectiveness of any sewer pipe maintenance strategy. It is important to note however that mainline maintenance practices also directly affect dry and wet weather combined sewer overflows (CSOs) as well as a small percentage of wastewater pump station-related overflows. Numerous costs, both proactive and reactive in nature, have been summed to provide the overall total cost of each maintenance strategy. Table 4 below shows how each of these factors contributes to the estimated total triple bottom line cost of each strategy. For further detail, see Appendix A.

Strategy Alternative	**A**	**B**	**C**	**D**	**E**
# FTEs	10	7	11	18	43
# Backups	1267	80	55	35	25
Investigation cost/backup (6 hrs/backup*$75/hr)	$450	$450	$450	$450	$450
Pipe cleaning costs (4 labor hrs/backup*$75/hr)	$300	$300	$300	$300	$300
Total Backup cost	$950,250	$60,000	$41,250	$26,250	$18,750
Unscheduled maintenance # of wo	636	636	636	636	636
Cost/wo (3.7 hrs * $75/hr)	$278	$278	$278	$278	$278
Total unscheduled maintenance costs	$176,490	$176,490	$176,490	$176,490	$176,490
PM # of wo	0	2017	3707	6962	17546
PM cost/wo (3.7 labor hrs * $75/hr)	$278	$278	$278	$278	$278
Total PM Cost	$0	$559,718	$1,028,693	$1,931,955	$4,869,015
# Claims	634	40	28	18	13
# Claims Paid	317	20	14	9	6
Avg payment per claim	$8,500	$8,500	$8,500	$8,500	$8,500
Avg administrative cost per claim	$5,000	$5,000	$5,000	$5,000	$5,000
Total Claims Cost	$4,276,125	$270,000	$185,625	$118,125	$84,375
Regulatory fine per backup	$1,000	$1,000	$1,000	$1,000	$1,000
Total Reg Costs	$1,267,000	$80,000	$55,000	$35,000	$25,000
Environmental/social costs per backup	$3,000	$3,000	$3,000	$3,000	$3,000
Total Env/Social Costs	$3,801,000	$240,000	$165,000	$105,000	$75,000
Total Annual Cost	$9,203,865	$1,306,208	$1,597,058	$2,357,820	$5,223,630

Table 4: Annual Cost Assumption Summary

The costs for preventative maintenance (PM) and unscheduled work were developed from data in the Hanson work order system. Costs for claims, regulatory, environmental and social impacts utilized data presented in a previous AMC report.

The table above shows how the costs for each alternative vary in magnitude. But, this does not tell the whole story. The parties responsible for the related costs of a given alternative also varies. Figure 5 below show the total annual cost including the private vs. public cost allocation of each alternative. As the alternatives move from reactive to proactive, the cost shifts from the private property owner to SPU.

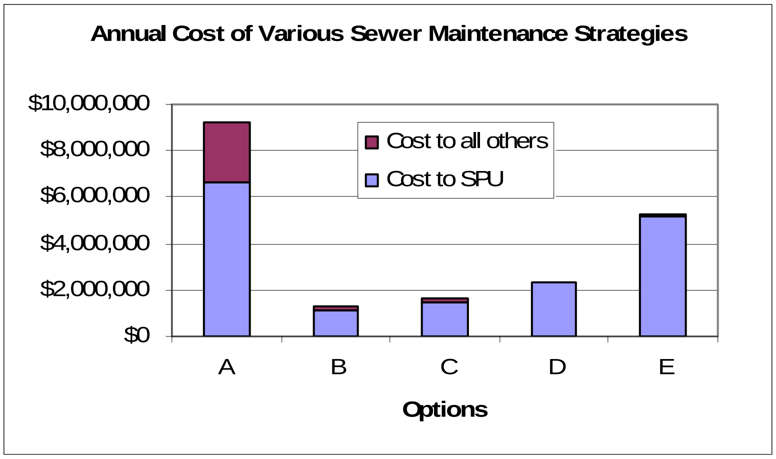


Figure 5: Annual Cost Allocation

Sensitivity Analysis

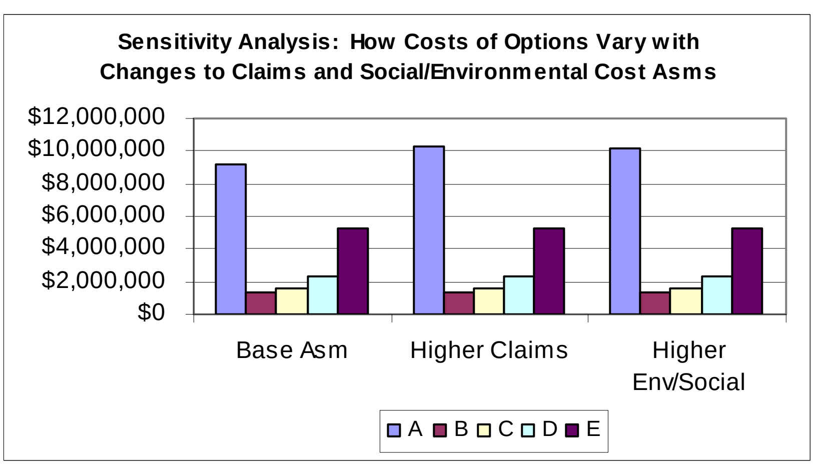
In order to review the robustness of the comparative results among the options, staff did a variety of sensitivity analyses on the assumptions used. These analyses are discussed below.

Changing Claims Costs and Social/Environmental Costs

For each of the options, significant claims and social/environmental costs were assumed. The base case assumptions for these costs are:

- Claims costs are based on the number of backups. Staff assumed that the number of claims filed would be half the number of total backups, and half of the number of claims filed would be successful.
- The average cost per successful claim was estimated at $13,500, based on recent actuals.
- $3,000 in social/environmental costs per backup was assumed.

In the sensitivity analyses, staff assumed that (a) claims costs were 25% higher for each option than what was assumed in the base case; and (b) social/environmental costs were 25% higher for each option than what was assumed in the base case. The results of these changes in assumptions are shown in the graph below. As can be seen in the graph, while the total cost of each option changes as the assumptions change, the relative ordering of costs among the options remains the same (that is, Option A is still the most costly, then Option E, then Option D, then Option C, then Option B).



Changing Backup and Preventative Maintenance Assumptions

Backups and preventative maintenance levels are the other major drivers of the costs in each option. The base case assumptions for these costs are:

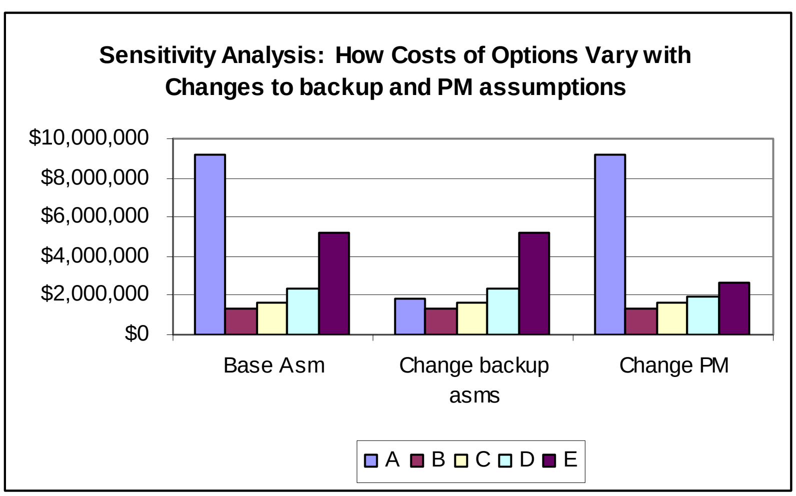
- The number of backups assumed is based on actual current backups and estimates of how this number changes as we change the level of preventative maintenance effort. Option A assumes backups at 25% of the 2006 scheduled work orders. Option B assumes 2004 actual backup levels. Option C assumes 2004 actual levels less the number of backups caused by missed maintenance. Options D and E assume small ramp downs of the number of backups as preventative maintenance is increased.

- The number of preventative maintenance work orders performed is based on actual current work orders and estimates of how this number changes as we change levels of effort. Option A, the purely reactive option, assumes zero preventative maintenance. Option B is set at the 2004 actual level of work orders completed. Option C is the actual 2006 scheduled preventative maintenance work orders. Option D is the 2006 scheduled work orders, plus preventative maintenance on all pipes in problematic areas. Option E assumes preventative maintenance on all pipes every 3 years.

In the sensitivity analyses on backups and preventative maintenance, we varied these assumptions as follows:

- For backups, we kept the base case assumptions for Options B through E. For Option A, we assumed that the number of backups was triple that of the current level. This is a much less conservative number than in the base case, and as can be seen in the graph below, dramatically decreases the cost of Option A. However, Option A continues to be more expensive than either Option B or C.

- For preventative maintenance, we kept the base case assumptions for Options A, B, and C. For Option D, we assumed a 50% increase in work orders completed relative to Option C. For Option E, we assumed a 50% increase relative to Option D. These assumptions significantly lower the amount of preventative maintenance assumed for these two options. However, the relative ordering of costs among the options is not affected.



Risk Analysis

The economic analysis focuses on only part of the risk factors SPU has identified as critical. The table below attempts to characterize the risk profile of each alternative with respect to the corporate risk model.

sk ype	Strategy A			Strategy B			Strategy C			Strategy D			Strategy E		
	Impact	**Prob**	**Risk**	**Impact**	**Prob**	**Risk**	**Impact**	**Prob**	**Risk**	**Impact**	**Prob**	**Risk**	**Impact**	**Prob**	**Ri**
viron- ntal	Moderate	Likely	High	Moderate	Possible	Medium	Minor	Unlikely	Low	Minor	Unlikely	Low	Minor	Rare	Lo
blic ust	Major	Almost Certain	Critical	Moderate	Possible	Medium	Minimal	Unlikely	Low	Minimal	Rare	Low	Minimal	Rare	Lo
ets/ vice iabilit	Moderate	Almost Certain	High	Minor	Almost Certain	Medium	Minor	Possible	Mediu m	Minor	Unlikely	Low	Minor	Rare	Lo
urity	Minimal	Rare	Low	Minimal	Rare	Low	Minimal	Rare	Low	Minimal	Rare	Low	Minimal	Rare	Lo
ety	Minor	Unlikel y	Low	Minor	Unlikely	Low	Minor	Unlikely	Low	Minor	Unlikely	Low	Minor	Unlikely	Lo
gal	Extreme	Likely	Critical	Moderate	Likely	High	Minor	Likely	Mediu m	Minor	Possible	Mediu m	Minor	Rare	Lo
ancial	Moderate	Likely	High	Minimal	Rare	Low	Minor	Likely	Mediu m	Moderate	Likely	High	Moderate	Likely	Hig
rk ce	Minimal	Rare	Low	Minimal	Rare	Low	Minimal	Rare	Low	Minimal	Rare	Low	Minimal	Rare	Lo

As shown, there is no one ideal alternative that provides a low risk rating in all categories. However, Strategy C appears to have the lowest risk profile overall.

Recommendation – Strategy C (But, not yet)

The economic analysis shows Strategy B has a $300,000 cost advantage over Strategy C. However, the analysis does not evaluate the future impacts of Strategy B discussed in this business case. The potential increasing cost profile related to the estimated claim, social and environmental costs for Strategy B, eliminate it as a viable long term option. As such it is recommended that Strategy C be pursued.

Implementation of this strategy would accept the approach of allowing one maintenance related back up to occur in any mainline not currently on a preventative maintenance schedule. Once the first back up occurs, that mainline will be placed on a preventative maintenance schedule to prevent future back ups. The maintenance schedules will be set using a "just in time" criteria. A schedule set too frequently will result in unnecessary costs to the city through additional O&M expenditures. A schedule set not frequent enough will result in additional back ups and claim related costs.

Strategy C is composed of the following characteristics:

- Moderate reduction in the amount of sewer backups as are currently experienced
- Moderate reduction in current reactive (non-scheduled) pipe cleaning maintenance
- Moderate reduction in existing sewer backup claims-related costs
- Moderate reduction in existing environmental and social costs due to sewer backups
- Moderate reduction in potential regulatory non-compliance fines due to sewer backups
- Modest increase in current proactive (scheduled) pipe.

As the economic analysis indicates, there is a gap between the resource available, Strategy B, and the recommendation. The analysis shows current resource allocation as 7 FTE and Strategy C identifies 11 FTE's for full implementation. However, no additional staff or funding is being asked for at this time. Significant more work in two areas need to occur before additional resources can be requested.

1. Complete implementation plan – see following section
2. Complete remaining maintenance strategies – While this strategy show the need for more resources, other strategies may identify available resources that could be reallocated to these activities.

Implementation Plan

The gap section above detailed several initiatives to achieve the recommended strategy. There are a series of actions Strategic Operations will focus on to increase the overall program and crew efficiency. The following section outlines the next steps in this process.

Over the next four years, Strategic Operations is projecting a 13% reduction in cleaning schedules resulting from the following process improvement initiatives;

- WMS schedule review
- pre-cleaning inspections
- Re-designed root treatment program

- Grease Abatement Program in coordination with Community Services

Additionally, Strategic Operations will work with DWD to achieve an 8% improvement in crew efficiency through a focused effort on crew utilization. These improvements will be achieved through the implementation of a 1st response crew and improved work order management.

Immediate Actions

1. Complete service agreement with Community Services group to define expectations for new Grease Abatement Program.
2. Implement WMS schedule review.
3. Implement pilot program to test effectiveness of pre-cleaning inspection using the zoom technology.
4. Implement crew efficiency improvement process focusing on reduction in travel time, down time and impacts from reactive maintenance requirements.

Performance Targets

If this recommendation is approved, the following performance targets will become part of DWD's Asset Maintenance Agreement (AMA) with Strategic Operations.

1. Complete all preventative maintenance schedules within the month release to crews.
2. Manage productivity to achieve a unit cost defined in the table below.

Activity	**Unit Cost**
Jetting	Still gathering data
Rodding	Still gathering data
Hydrocutting	Still gathering data
Dragging	Still gathering data
Chemical Root Treatment	Still gathering data

SEATTLE PUBLIC UTILITIES
WASTEWATER SYSTEMS PLAN

APPENDIX G

METHODOLOGY FOR OPTIMIZING SEWER REHABILITATION TIMING

DRAFT

TECHNICAL MEMORANDUM

Seattle Public Utilities
Wastewater Comp Plan (27261)
Task 6 – Comp Plan

Date: December 2005

To: Bill Wells, SPU
Jon Shimada, SPU
Tim Skeel, SPU

From: Darin Johnson, BC

Copy to: Andrew Lee, BC
Scott Anschell, BC
File

RE: Methodology to Optimize Timing of Sewer Rehabilitation

PURPOSE OF RISK-BASED PLANNING PROCESS

The process for planning SPU's long-range sewer pipe rehabilitation program, described in this document, optimizes and justifies the timing of pipe lining based on the economics of system ownership. This methodology balances the cost from increasing risk of failure as the pipe ages against the benefit of delaying capital expenditures to rehabilitate (i.e., line) the pipe as long as possible. The optimal strategy is the one that minimizes the total cost of ownership, defined as the sum of the risk and capital costs. This tradeoff is shown in the figure below.

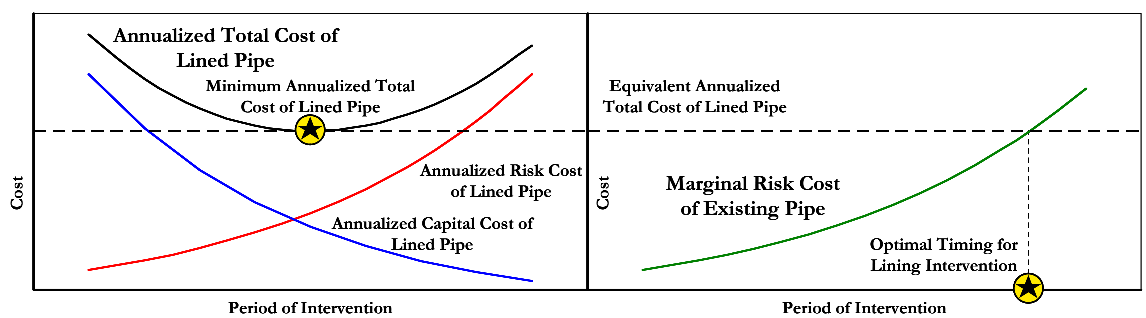


Figure 1: Optimization of Pipe Intervention Timing

The figure above shows that as the timing for the pipe lining is delayed, the annualized capital cost decreases due to discounting and spreading the payments over a longer period. However, the annualized risk cost increases as the pipe ages and the likelihood of failure increases. The sum of capital and risk cost is the total cost of ownership, which typically follows a U-shaped curve over time. The minimum point of that curve represents the optimum value for pipe lining, since the total cost of ownership is at its minimum. Annualized cost can be thought of as the yearly payment required to support the stream of capital costs or risk cost.

This principle is the basis for the Risk-based Planning strategy, developed as part of the Wastewater Systems Plan. The process and the underlying assumptions used are described below.

Development of Risk Costs

Risk costs for both the lined pipe and the existing pipe are calculated by multiplying the pipe's consequence of failure by its probability of failure. The development of consequence cost of failure and probability of failure is described below.

Consequence Cost of Failure

The consequence cost of failure for a sewer comprises all the costs associated with the failure of a pipe, including the cost to repair the pipe, damage to customers from backups, and any social and environmental costs expected. Some sewer failures can be addressed through a planned point repair. Other failures that are more severe and identified too late require an emergency point repair. In some cases, a sewer failure leads to a sewer backup, in which case the consequences are both an emergency point repair and the costs of responding to the backup, subsequent claims, and potential social costs. All of these failure scenarios have different consequence costs. In order to address this, our methodology used the average consequence cost of these failure scenarios, weighted by their relative probabilities. There are different distributions of failure scenarios for High Risk sewers and sewers that are Non-High Risk. The direct cost of point repair is based on the emergency point repair costs in SPU's Sewer Pipe Risk Model.

<u>High Risk Sewers</u>
The high risk sewers are inspected on a five-year period by CCTV camera. As such, we expect that most failures will be caught before they reach the point of collapse and backup. The figure below shows the consequences and failure distributions assumed for the high risk sewers and the source of the consequence cost data.

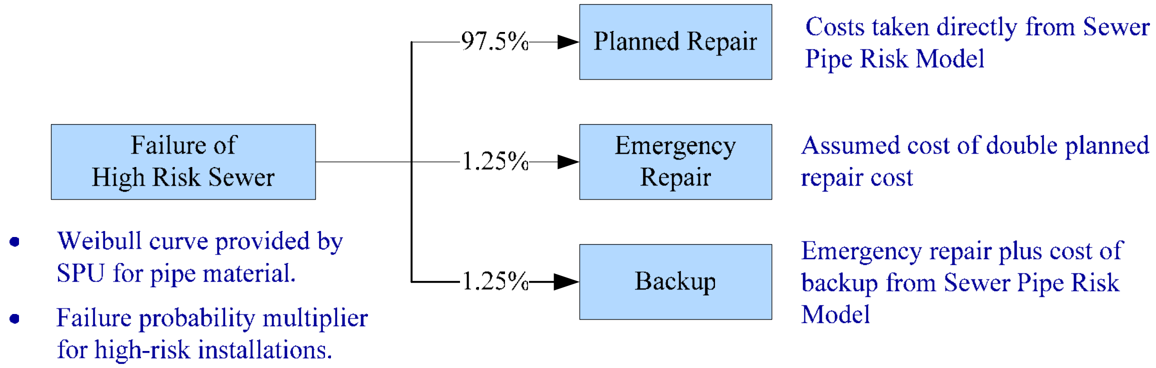


Figure 2: High Risk Sewer Failure Consequences

For this analysis, we assumed that virtually all failures in the high risk sewers, 97.5 percent, are repaired on a planned basis. The remaining 2.5 percent were split evenly between emergency repairs with and without backup. These rates were based roughly on the historical rate of backups and emergency repairs at SPU. The expected consequence cost is the weighted average of the three consequences shown (i.e., planned repair, emergency repair, backup).

Example: Calculation of Expected Consequence Cost for a High Risk Sewer
Sewer A is a high risk sewer and has a direct repair cost of $12,000, based on the Sewer Pipe Risk Model. The indirect cost of failure is $36,000.. Therefore, the total consequence cost of failure for this sewer is calculated as follows:

Planned Repair Cost x 97.5% = $12,000 x 0.975 = $11,700
Emergency Repair Cost x 1.25%= ($12,000 x 2) x 0.0125 = $300
Backup Cost x 1.25%= [($12,000 x 2) + $36,000] x .0125 = $750

TOTAL CONSEQUENCE COST = $11,700 + $300 + $750
= $12,750

<u>Non-High Risk Sewer</u>
The non-high risk sewers are inspected infrequently, as part of the regular sewer cleaning process or not at all. Because of this, it is much more likely that failures of non-high risk sewers will only be discovered when a backup has occurred. Furthermore, some failures will remain undiscovered, having no consequences. The figure below shows the consequences and probabilities assumed for the non-high risk sewers and the source of the consequence cost data.

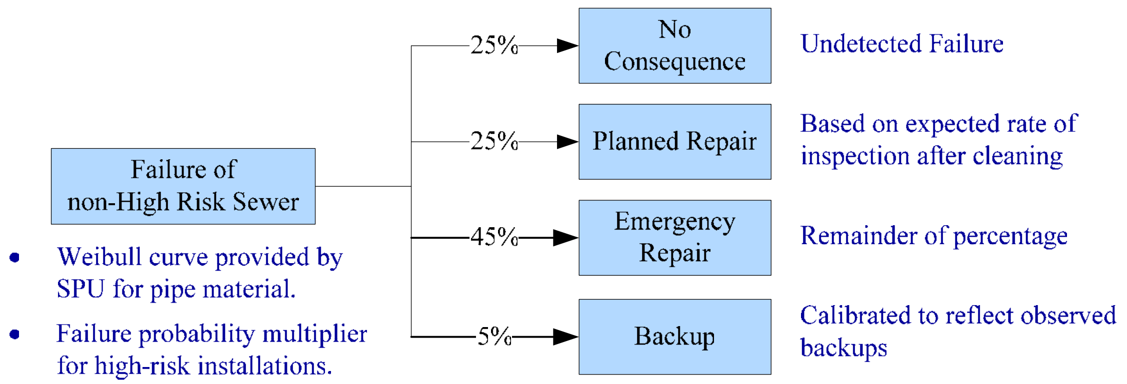


Figure 3: non-High Risk Sewer Failure Consequences

For non-high risk sewers, the relative probability of a backup occurring is much higher than for high risk sewers, which are inspected regularly. This is because failures will not be discovered during a CCTV inspection, and therefore a failure will not be prevented or repaired before it progresses to the point of creating a backup. The probabilities shown above for the non-high risk sewers are estimates based on the engineering judgment of Brown and Caldwell and SPU, as described below.

- Twenty-five percent of the non-high risk sewers are part of the cleaning program, and are subject to a low level inspection. These sewers are cleaned every 6 months to 3 years. We assume that these sewers are inspected regularly enough that any failures will be noticed and will have a planned repair.

- We assume that twenty-five percent of the time a failure will result in a do-nothing as it will cause no backups and will likely go unnoticed.

- The percentage of failures in a non-high risk sewer that will lead to backups was calibrated to the actual number of observed backups per year. The observed seven backups in 2005 yield a calibration of five percent.

- The percentage of time that an emergency point repair will be required was backcalculated by subtracting the percentages of planned, do-nothing and backups scenarios. That percentage was backcalculated to be 45 percent.

Example: Calculation of Expected Consequence Cost for a Non-High Risk Sewer
Sewer B is a non-high risk sewer and has a direct repair cost of $18,000, based on the Sewer Pipe Risk Model. The indirect costs of failure are $56,000, also based on the Sewer Pipe Risk Model. Therefore, the total consequence cost of failure for this sewer is calculated as follows:

Planned Repair Cost x 25% = $18,000 x 0.25 = $4,500
Emergency Repair Cost x 25%= ($18,000 x 2) x 0.45 = $16,200
Backup Cost x 25%= [($18,000 x 2) + $56,000] x 0.05 = $4,600

TOTAL CONSEQUENCE COST = $4,500 + $16,200 + $4,600
= $25,300

<u>Percentage of High Risk and Non-High Risk Sewers</u>
The percentage of sewers that are considered "high-risk" sewers and are inspected on a 5-year cycle is currently 15% of the total number of sewer segments. The list of "high-risk" sewers, however, is not a static list. Although consequence costs of failure for sewers remain unchanged over time, the probability of a sewer's failure increases with age. Therefore, a sewer that is currently considered "low-risk" may be considered a "high-risk" sewer in the future. Because the consequence costs of failure were calculated based on whether a sewer was "high-risk" or non high-risk sewer, it was necessary to make a determination on whether a particular sewer was likely to ever be a high-risk sewer, or would most likely always be a non high-risk sewer. Analysis of the 15% high risk sewers revealed that the majority (87%) of them had point repair greater than $43,000. The analysis also revealed that only 39% of all the sewers had point repair costs greater than $43,000. Therefore, we assumed that any sewer with point repair greater than $43,000 was likely to become a high-risk sewer in the future. These pipes were treated as high-risk sewers in the analysis, even though they may not currently be considered high-risk sewers.

Failure Probability

The probability of a sewer pipe failure is a function of its material and its age. As the pipe ages, the likelihood that it will fail in a given year increases. Curves defining the rate of failure used in this analysis were provided by SPU. They are Weibull curves with parameters shown in Table 1 below.

Table 1
Failure Probability Weibull Curve Parameters

PIPE MATERIAL	ALPHA	BETA	"FIRST FAIL"
Concrete	100	3	20
Vitrified Clay (VC)	120	3	20
Relined	50	3	20

The alpha and beta terms define the scale and skew of the density curve, respectively. The "first fail" defines the offset of the curve. These parameters imply the hazard rate or annual conditional failure probability versus age.

These failure probability curves are shown below.

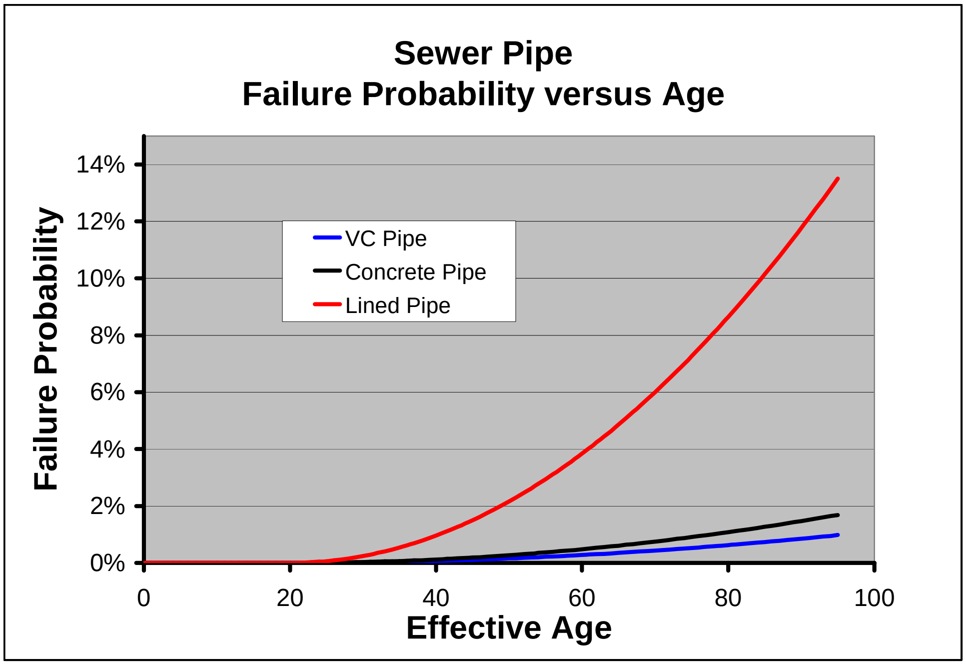


Figure 4: Failure Probability versus Age

The curves show that at any given age, the failure probability of the VC pipe is lowest, followed by concrete pipe, and then relined pipe. No distinction has been made between different materials or conditions once the pipe has been relined.

The age and material of the pipes were taken from the Sewer Pipe Risk Model.

PIPE RENEWAL COSTS AND EFFECTS

Planning a replacement and rehabilitation program requires understanding not only the likelihood and consequences of failure, but also the effects of intervention. In this analysis, the intervention mode considered is pipe lining. Generally, we must estimate the cost of lining each pipe and the effect that lining is expected to have on failure probability.

Cost of Lining

The pipe database used to estimate lining costs was taken from SPU's Geographical Information System (GIS), since that was determined to be the most accurate source of pipe depth, diameter, and length information. Refer to Appendix H for a summary of the cost estimating methodology for determining lining costs.

Effect of Lining

The benefit of lining a sewer pipe is to reduce its failure probability, which reduces risk cost. The effective age of the pipe drops to zero, and the pipe moves onto the lined pipe Weibull curve. The Weibull curve for the lined pipe increases significantly more rapidly than the curves for concrete or VC pipe. The figure below shows the progression in failure probability for a concrete pipe that is lined at age 100 years.

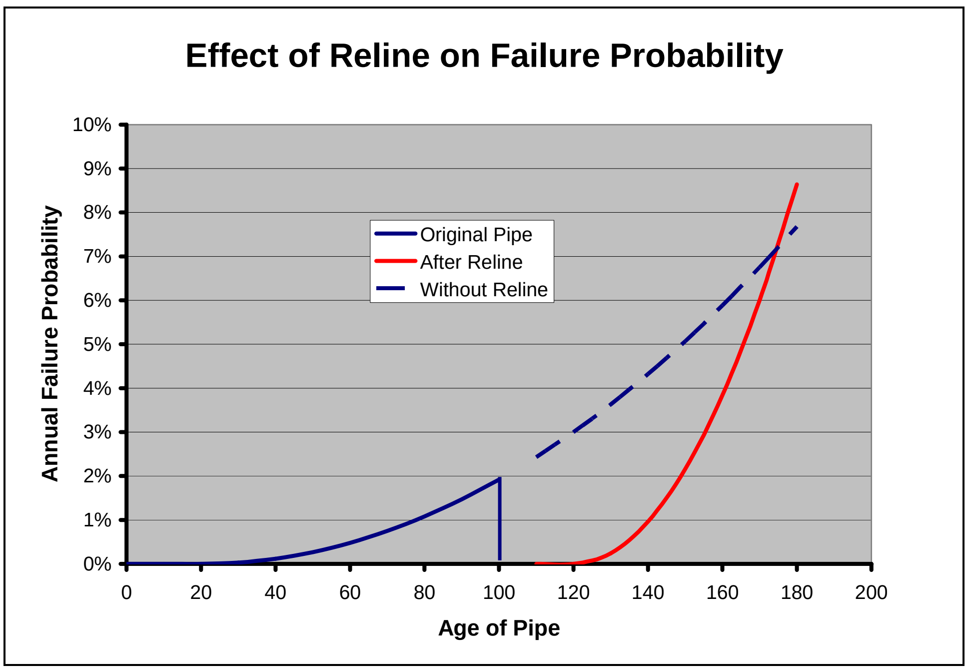


Figure 5: Effect of Lining on Failure Probability

As shown in the figure, lining the pipes produces a near-term reduction in failure probability and risk cost.

Our analysis is based on the assumption that the intervention strategy for all sewers is to line rather than replace. In some cases (where the pipe is very old, in very poor condition, or already lined) lining may not be practical. We have not identified these cases in our analysis, but their effect on long-term capital and repair costs is not expected to be significant. Also, the annualized cost of the lined pipes (described below) does not account for the fact that the subsequent interventions after the first lining will be replacement.

CALCULATION AND GENERATION OF PROGRAM

The following sections describe the calculations used in the Sewer Rehab Risk-based Planning Model.

Categorizing Components

The categories in the Risk-based Planning model correspond to the unique combinations of material type, consequence cost, and per-foot lining cost for each sewer segment. The categories of material type are separated into concrete, vitrified clay, and "other." The consequence cost used is the "Adjusted Effective Consequence of Failure (incorporating Failure Modes)," from SPU's Sewer Pipe Risk Model. It is the cost of a planned spot repair, multiplied by a factor indicating a higher-than-normal likelihood of failure, due to the particulars of the installation. In the discussion below, the Adjusted Effective Consequence of Failure is referred to as the consequence cost; however, strictly speaking, it is not the full consequence cost, as described in the section above about determining the expected consequences of failure.

Table 2 shows the categories of consequence cost and per-foot lining cost used.

Table 2
Consequence Cost and Per-Foot Lining Cost Categories

Consequence	Label	Lining	Label
$7,175.00	01	$69.75	01
$8,425.00	02	$89.07	02
$9,525.00	03	$108.39	03
$9,675.00	04	$133.50	04
$11,362.50	05	$147.03	05
$11,550.00	06	$168.97	06
$12,175.00	07	$170.90	07
$12,525.00	08	$197.95	08
$13,200.00	09	$231.78	09
$13,425.00	10	$265.59	10
$14,675.00	11	$297.86	11
$15,112.50	12	$320.87	12

Example: Categorizing Pipes in Risk-based Planning model
Component 184715 is a concrete pipe with a lining cost of $69.75 per foot and a consequence cost of $13,425.

According to Table 2, the component 184715 would have a label category of CON-C10L01, where "CON" indicates the material type (concrete), "C10" indicates the Consequence is category 10, and "L01" indicates the per-foot lining cost is category 1.

The purpose of developing theses categories was simply to limit the number of calculations required to assess the entire system. By keeping the number of calculations smaller, we were able to build this model in Excel rather than a database program such as Access. We consider this an advantage due to Excel's ubiquity and transparency.

Calculating Optimal Timing for Lining Intervention for each Category

Once the categories were defined for the segments, the next step was to calculate the optimal timing of lining for each category. This calculation optimized the trade-off between risk cost and capital cost, as described in the beginning of this document. The calculation is performed in two steps, described below.

The first step is to calculate the annualized cost of the pipe once it is lined. The left side of Figure 6 shows the curves for the annualized capital cost and annualized risk cost for the lined pipe. The sum of the annualized capital lining cost and the annualized risk cost is the annualized total cost of ownership for the lined pipe. The minimum point on the annualized total cost curve is the minimum annualized total cost of lined pipe.

The second step is to determine the year in which the marginal cost of the existing pipe exceeds the annualized cost of the lined pipe. The right side of Figure 6 shows the marginal risk cost curve for the existing pipe, which is the additional risk cost the existing pipe accrues each year. The optimal timing for the lining intervention is the year in which the minimum annualized total cost of lined pipe is equal to the marginal risk cost of the existing pipe.

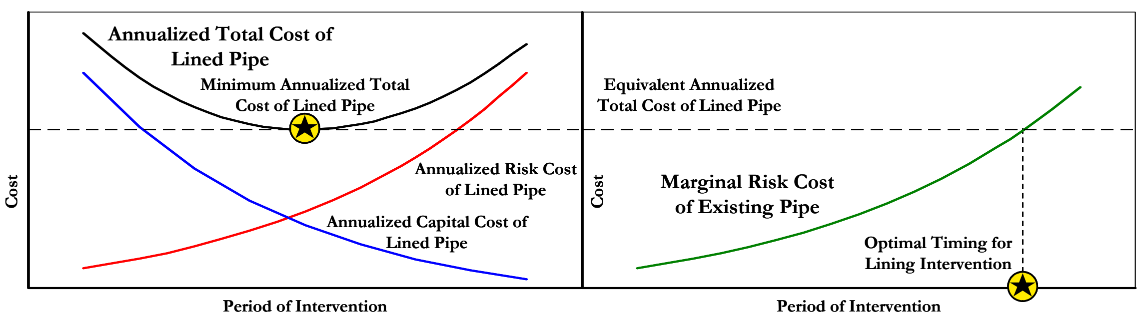


Figure 6: Optimization of the Timing of Pipe Lining

Relating Category Timings to the Sewer Pipe Database

The calculation of optimal timing was performed for each of the categories. These results were then applied to the database of pipes in the Sewer Pipe Risk Model. Each pipe in the database was identified with one of the categories in the Risk-based Planning Model, based on its material type, expected consequence of failure cost, and per-foot lining cost.

Creating Long-Range Capital Plan

Once the optimum timing of lining has been established for each pipe, the capital cost of all those that are scheduled within the planning horizon are collected to form a capital budget. Figure 7 below shows the first 20 years of the capital cost for pipe lining based on these results. The costs shown are a five-year running average.

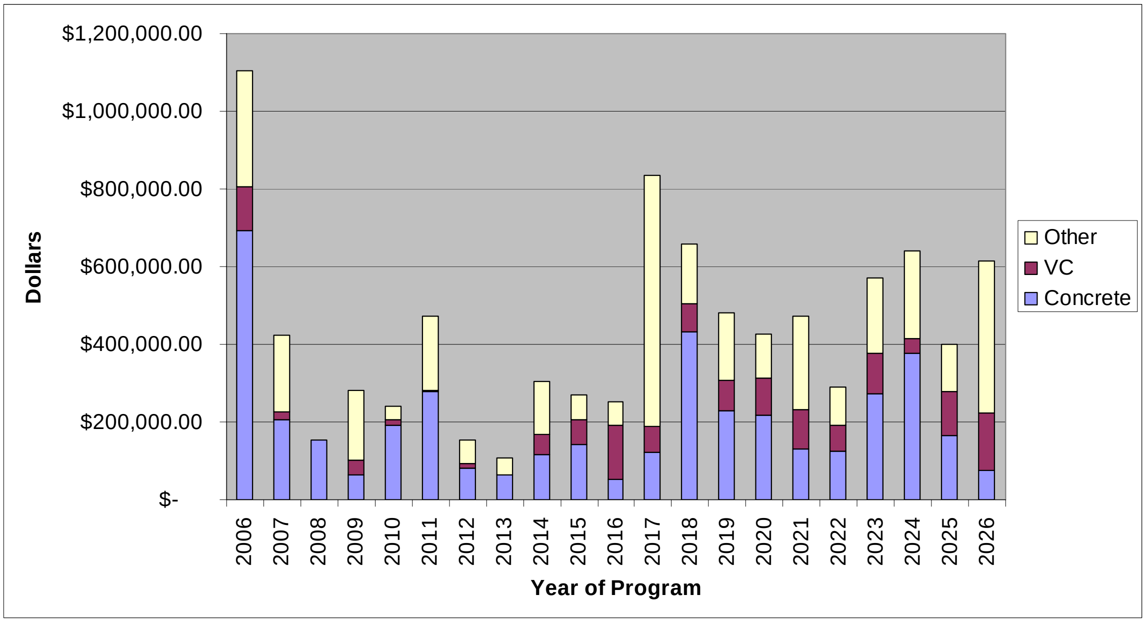


Figure 7: Scheduled Lining Capital Costs

Calculating Long-Term Point Repair Costs

This model was also used to project the cost of future point repairs. These streams of risk cost, calculated in determining the economic life of each category, are the basis for this projection. Point repair costs were extracted from the total risk cost streams for each pipe segment. As described before, the risk costs for both the lined pipe and the existing pipe are calculated by multiplying the pipe's consequence of failure cost by the pipe's probability of failure; however, this total risk cost streams include the costs due to backups and other consequences not related to pipe repair.

For instance, some sewer failures can be addressed through a planned point repair, while other failures that are more severe and identified too late require an emergency point repair. In some cases, a sewer failure leads to a sewer backup, in which case the consequences are both an emergency point repair and the costs of responding to the backup, subsequent claims, and potential social costs. The fraction of the consequence cost that is related to the direct repair (without the costs related to the backup) was extracted using the defined failure distributions.

Projecting Overall Sewer Rehabilitation Program Costs

The sewer lining cost projections were added to the point repair projections to yield an overall sewer rehabilitation program cost stream. Figure 8 shows the yearly projected costs for repair and lining.

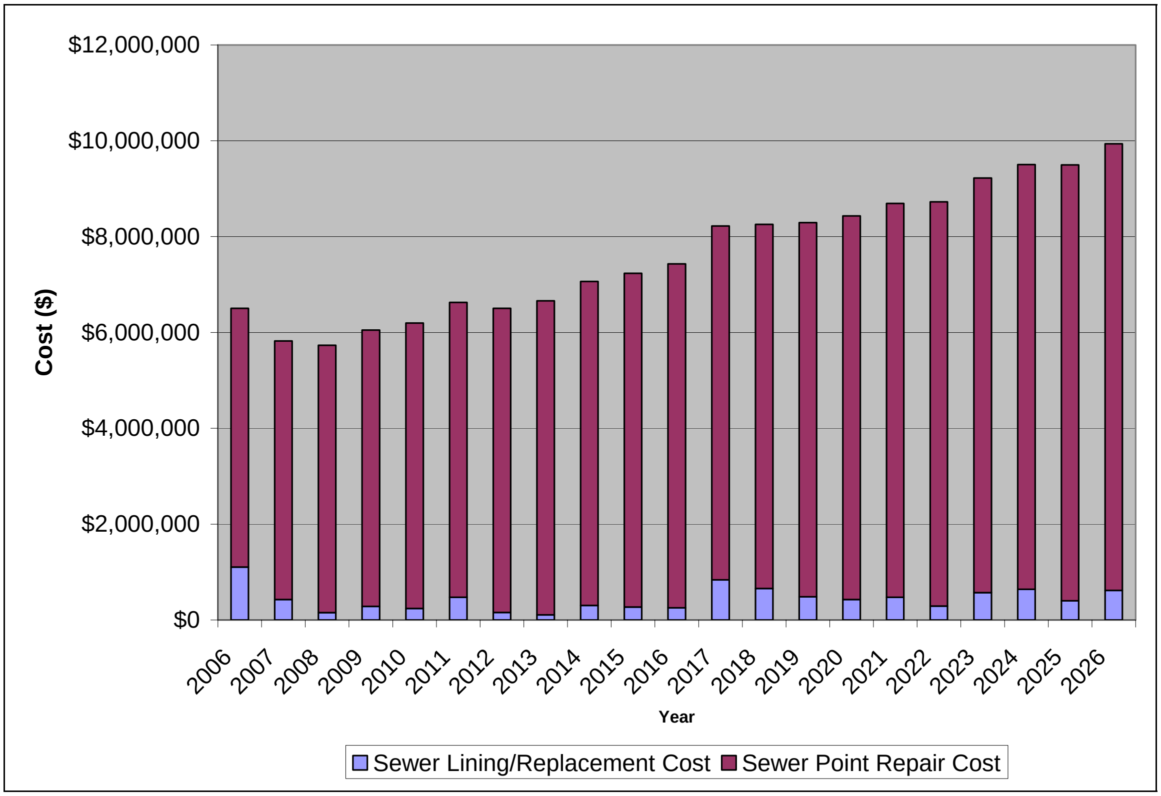


Figure 8: Projected Costs

IMPLICIT ASSUMPTIONS

In addition to the quantitative estimates and assumptions discussed above (e.g., lining costs, discount rate, repair cost, etc.) there are several assumptions implicit in this methodology that we note here. The intent is not to discuss these in detail, but only to note them for future consideration.

- The only intervention mode considered is lining of the pipes. As discussed above, it may not be possible to line some pipes due to poor condition or their having been lined already. Also, the annualized cost of the lined pipe does not account for the fact that the subsequent interventions after the first lining will be replacement.

SEATTLE PUBLIC UTILITIES
WASTEWATER SYSTEMS PLAN

APPENDIX H

SENSITIVITY ANALYSES FOR SEWER REHABILITATION COST PROJECTIONS

BROWN AND CALDWELL

TECHNICAL MEMORANDUM

Seattle Public Utilities
Wastewater Comp Plan (27261)
Task 6 – Comp Plan

SENSITIVITY ANALYSIS

Appendix G presents the methodology used to project the sewer rehabilitation needs for the next 25 years. As documented in Appendix L, a number of assumptions were made to develop the cost projections. Sensitivity analyses were performed to determine the relative contributions of assumed factors towards the cost projections for sewer rehabilitation. Three factors were identified as having significant impacts on the resulting cost streams:

- Discount Rate
- Non-High Risk Failure Distributions
- Social Costs per Backup

The results of the sensitivity analyses provide ranges for the possible costs. Since the three listed factors were assumed values, performing the sensitivities indicated the extent to which the cost projections will change if the factors also change. Furthermore, since the results of the Risk-Based Replacement Model are cost projections based on probabilities, performing sensitivity analyses also indicates a range wherein the future incurred costs will likely be.

The Sensitivity Analyses performed are summarized in Table 1.

Table 1. Summary of Sensitivity Analyses

Analysis	Baseline	Variations
Discount Rate	5%	3%
		7%
Non-High Risk Failure Distributions • Imminent Failure Requiring Planned Point Repair • Failure Requiring Emergency Repair • Failure Resulting in Backups	• 25% Planned Point Repair • 45% Emergency Repair • 5% Backup	• 25% Planned Point Repair • 10% Emergency Repair • 5% Backup
		• 25% Planned Point Repair • 25% Emergency Repair • 5% Backup
Social Costs per Backup	$30k	$0k
		$50k
		$96k

For each sensitivity analysis, one variable was changed. For example, the baseline factors are 5% discount rate, 25% Planned / 45% Emergency / 5% Backup failure distribution, and $30k social costs per backup. The sensitivity analysis involved changing one of the baseline factors at a time, such as using a 3% discount rate while keeping the 25% Planned / 45% Emergency / 5% Backup failure distribution and $30k social costs.

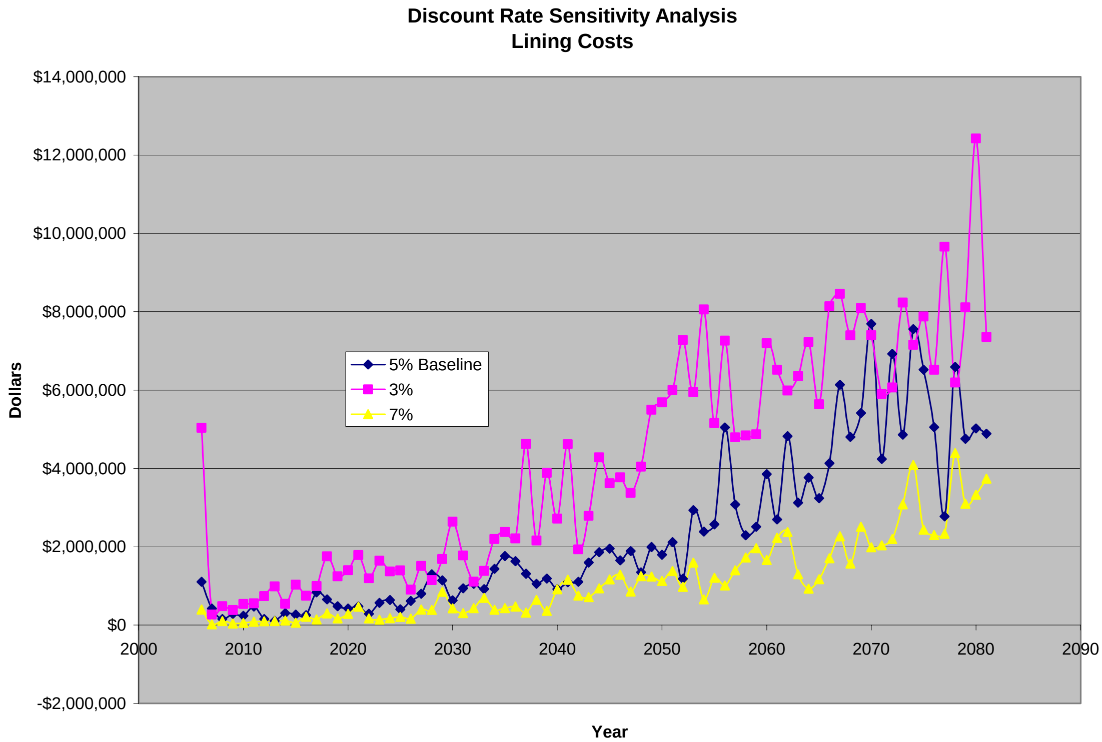
SUMMARY OF RESULTS

Varying the discount rate tended to change the timing of proactive sewer lining or replacement. For a 7% discount rate, the timing of proactive sewer lining/replacement tended to be later, and therefore the cost projections for total sewer rehabilitation were generally lower. For a 3% discount rate, the timing of lining/replacement tended to be earlier, and therefore the cost projection for lining/replacement tended to be higher by as much as $1 million annually.

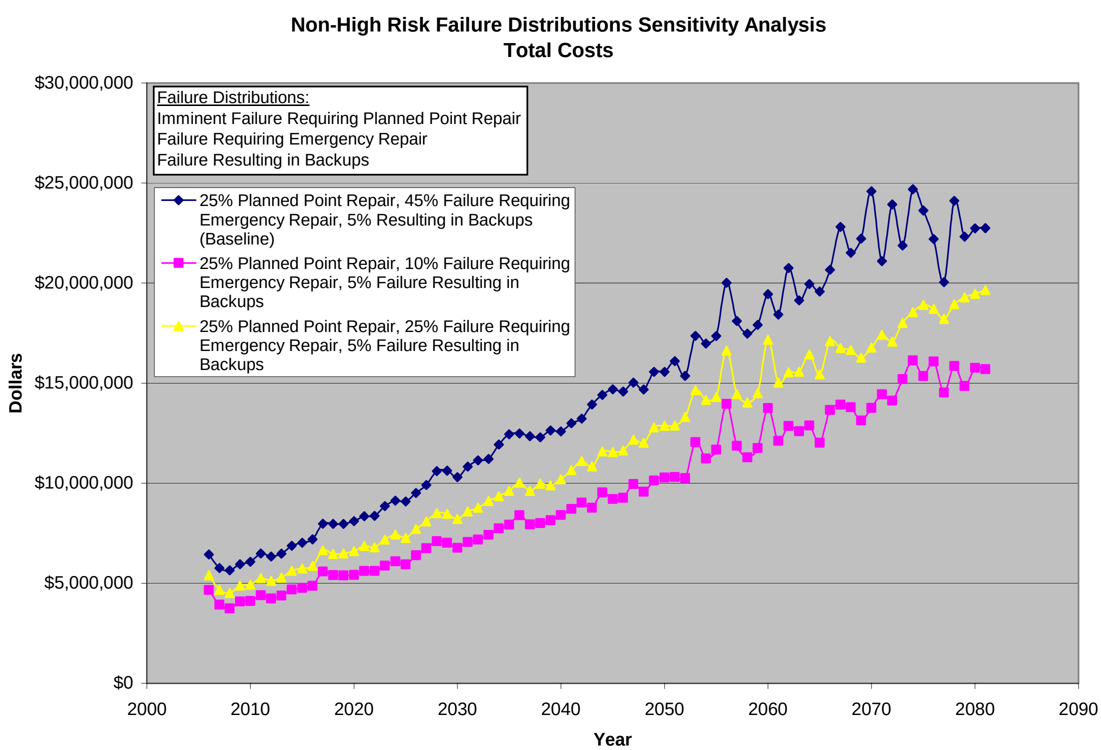
Varying the failure distributions indicate that the distribution of non high-risk sewer failures can influence the cost streams significantly. Over the next 25 years, the failure distribution of non high-risk sewer failures can either increase or decrease the annual sewer rehabilitation costs by up to $3 million.

The trends for the varying social costs per backup were minimal. Total sewer rehabilitation cost projections are similar to the baseline for the next 25 years. This is largely due to the small percentage of sewer failures resulting in backups that was assumed during the analysis for both high-risk and non high-risk sewers.

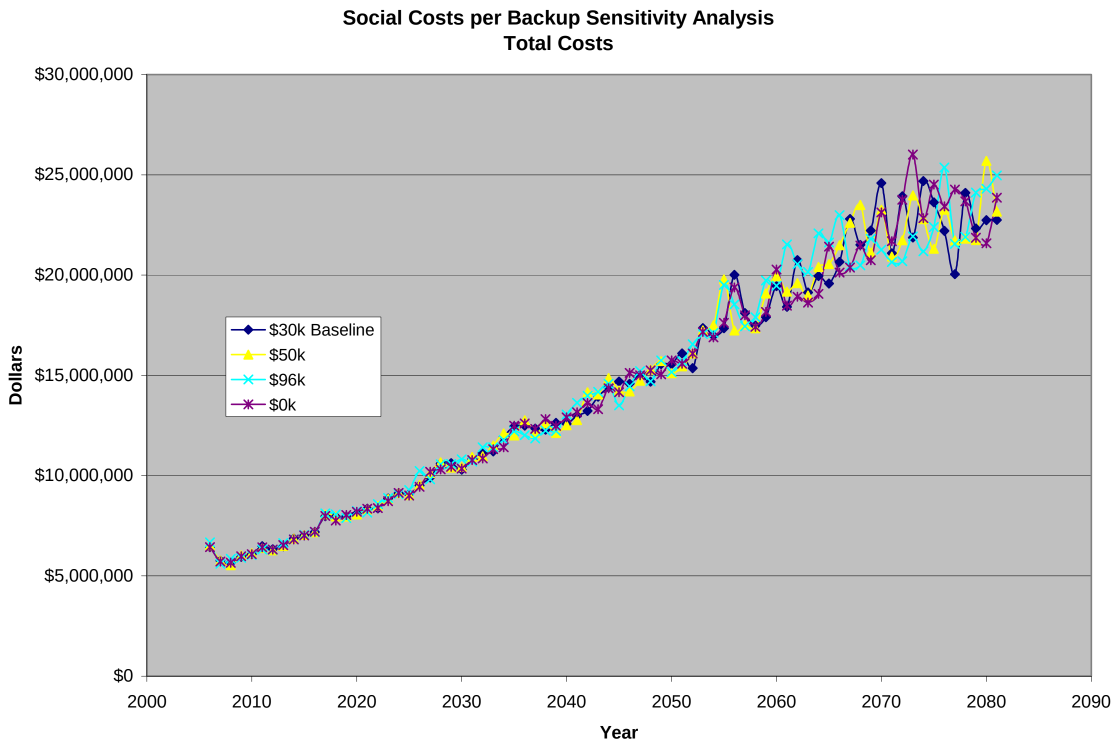
The charts on the following pages display the results of the sensitivity analyses.



Discount Rate Sensitivity Analysis
Lining Costs
$14,000,000
$12,000,000
$10,000,000
$8,000,000
$6,000,000
$4,000,000
$2,000,000
$0
-$2,000,000
Dollars
5% Baseline
3%
7%
2000
2010
2020
2030
2040
2050
2060
2070
2080
2090
Year



Non-High Risk Failure Distributions Sensitivity Analysis
Total Costs
Failure Distributions:
Imminent Failure Requiring Planned Point Repair
Failure Requiring Emergency Repair
Failure Resulting in Backups
25% Planned Point Repair, 45% Failure Requiring Emergency Repair, 5% Resulting in Backups (Baseline)
25% Planned Point Repair, 10% Failure Requiring Emergency Repair, 5% Failure Resulting in Backups
25% Planned Point Repair, 25% Failure Requiring Emergency Repair, 5% Failure Resulting in Backups
$30,000,000
$25,000,000
$20,000,000
$15,000,000
$10,000,000
$5,000,000
$0
Dollars
2000
2010
2020
2030
2040
2050
2060
2070
2080
2090
Year



Social Costs per Backup Sensitivity Analysis
Total Costs
$30,000,000
$25,000,000
$20,000,000
$15,000,000
$10,000,000
$5,000,000
$0
Dollars
2000
2010
2020
2030
2040
2050
2060
2070
2080
2090
Year
$30k Baseline
$50k
$96k
$0k

SEATTLE PUBLIC UTILITIES
WASTEWATER SYSTEMS PLAN

APPENDIX I

METHODOLOGY FOR PRIORITIZING CAPACITY PROJECTS

Prioritization of Capacity At-Risk Areas

PREPARED FOR:	Martha Burke, SPU
PREPARED BY:	Dan Pitzler, CH2M HILL
COPIES:	Mike O'Neal, Brown and Caldwell Andrew Lee, Brown and Caldwell
DATE:	November 8, 2005
PROJECT NUMBER:	317262.32.1A.05

This memorandum presents the results of an analysis to prioritize areas that may require increased sewer capacity to meet the level of service (LOS) established by Seattle Public Utilities (SPU). These areas of potentially insufficient capacity were identified using a hydraulic analysis of the wastewater collection and conveyance system (see Chapter 6 and Appendix 2). The analysis identified pipe segments that appeared to have insufficient capacity for various design storms. When the model output showed insufficient capacity coinciding with a history of customer complaints or claims, or if the insufficient capacity pipes were in the vicinity of an area where high growth or a major project is expected, those pipe segments were designated “Priority 1” or “at-risk” areas. Exhibit 1 provides a map that shows the 19 at-risk areas identified in that analysis.

These 19 areas are the areas that SPU should investigate and analyze in greater detail, because of the relatively high probability and consequences of sewer backups from insufficient pipe capacity in these areas. This memorandum reports the results of an analysis to prioritize those 19 areas yet further to assist SPU in its capital improvement planning process. It provides an overview of the value modeling methodology used to prioritize the at-risk areas, and the steps taken to conduct the prioritization.

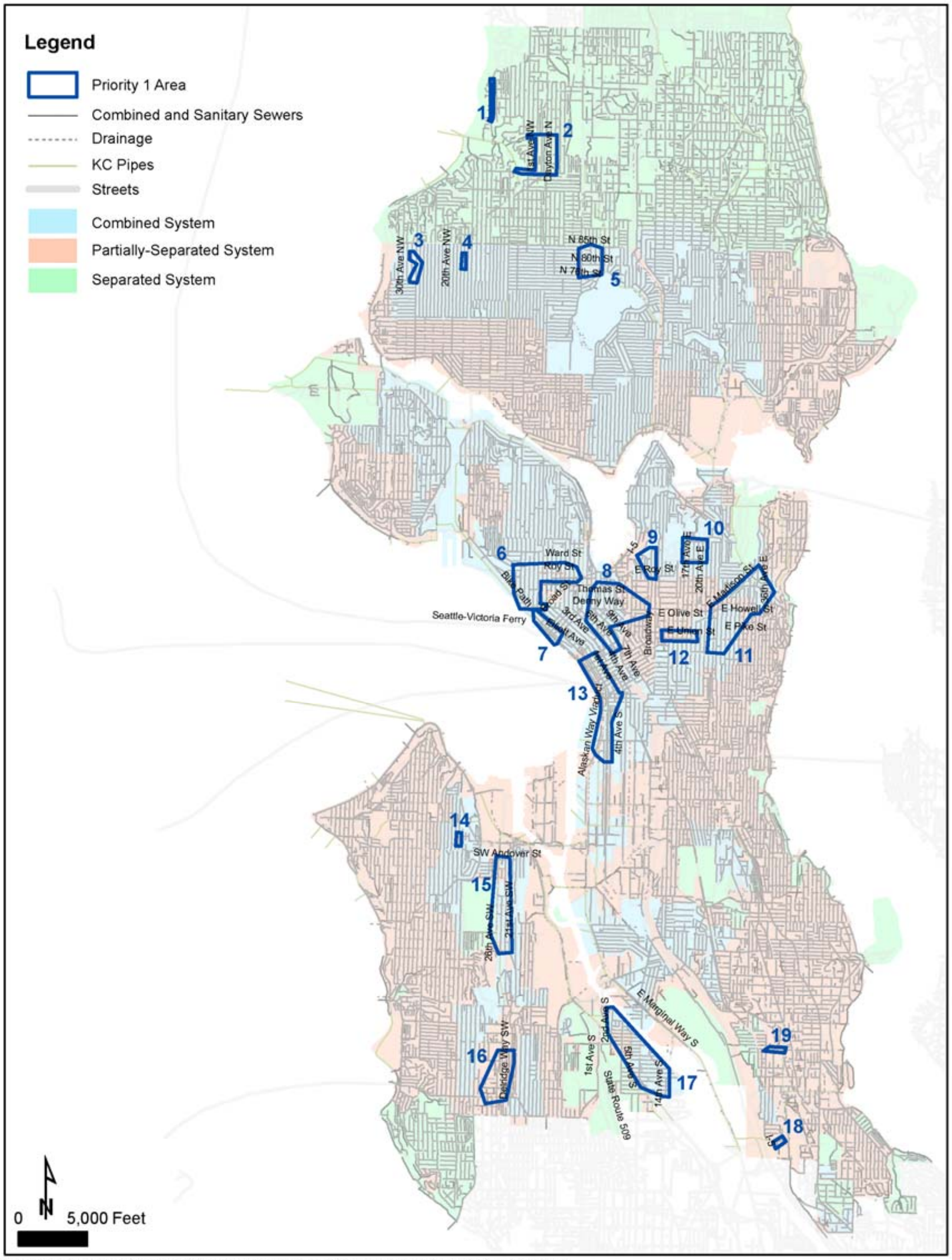
The analysis and results were conducted for the four levels of service investigated in this plan:

- 2-Year LOS
- 5-Year LOS
- 10-Year LOS
- 20-Year LOS

When sensitivity analyses are conducted, results are shown for the 5-Year LOS.

Contents

Exhibits



P:\04 Seattle Public Utilities\27261 SPU WW COMP PLAN\Background Mat\SvR data 2004\GIS data\Selection\With SPU Data 031005\Priority1_letter.mxd

EXHIBIT 1
Location of Priority 1 Capacity-Challenged Pipe Segments and At-Risk Areas

Overview of Value Modeling Methodology

Value modeling is a quantitative technique for making decisions that involve multiple financial, environmental, and social objectives. It is also consistent with the project development process (PDP) that is used help make resource allocation decisions at SPU.

Value modeling is referred to in the decision making literature as multi-criteria decision analysis, and the specific approach used for this analysis is SMART, the Simple Multi-Attribute Rating Technique.[1] This section provides a brief overview of the technique and describes how the technique is consistent with SPU's asset management goals and the project development process.

Value modeling proceeds through a series of defined steps. To clarify the discussion of steps in this introduction, a simple example is developed. The steps, illustrated in Exhibit 2 below, are:

- Establish the decision goal
- Identify and specify fundamental objectives
- Develop performance measures to assess project performance against objectives
- Add technical detail to the performance measures, and assign scores to the performance measures
- Assign weights to the objectives
- Calculate value scores and conduct sensitivity analysis

These steps are discussed in detail in the following sections.

Decision Goal

The decision goal is the overall purpose of the evaluation. It is that which is to be accomplished by making a decision. It should clarify what is included and excluded from the scope of the evaluation.

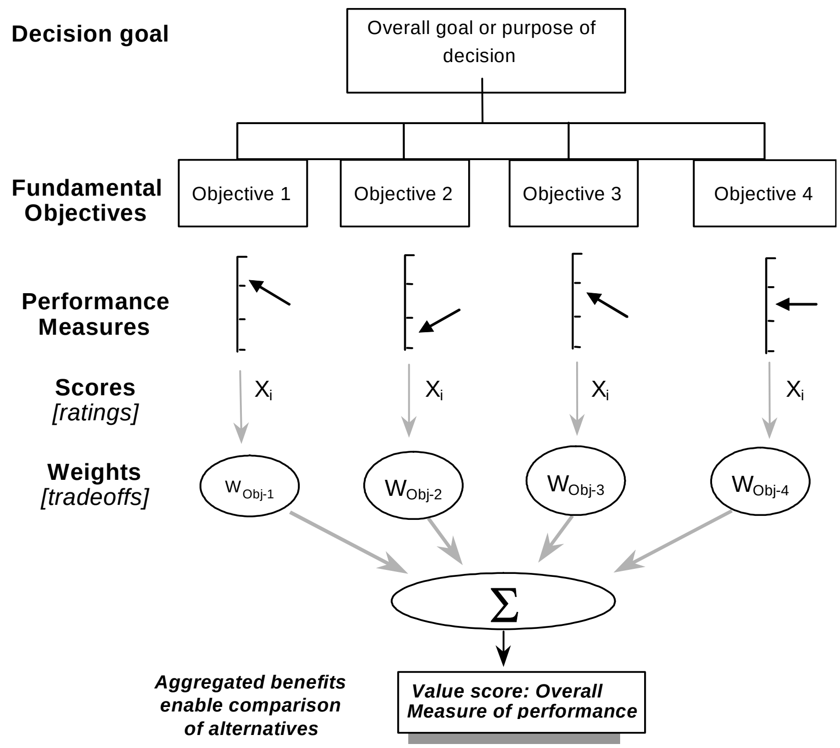
Values, Objectives, and Criteria

Objectives are the important non-monetary aspects of a decision that are arrived at through careful thinking about issues. In essence, they reflect repeated efforts to answer a simple question: "Why is this issue important?" When the response becomes, "Because it *is*," a fundamental value or objective has been identified.

Values, objectives, and criteria are often used almost interchangeably in decision analysis. Although this is not strictly correct, it rarely affects the quality of the analysis. Simply stated, values underlie and motivate objectives. An example of a value statement is, "An ecologically diverse environment is essential." Such a value motivates the objective, "reduce threats to the ecosystem." Fundamental objectives are the most basic elements in the model.

[1] Edwards, W. How to use Multiattribute Utility Theory for Social Decision Making, IEEE Transactions on Systems, Man, and Cybernetics 7,326-340, 1977, and Von Winterfelt, D. and W. Edwards. Decision Analysis and Behavioral Research, Cambridge University Press, 1986.

EXHIBIT 2
Generalized Representation of Value Modeling
See text for discussion of the figure. X_i represents the score of alternative "i" on the given objective. Weights are the relative importance assigned to each objective. $\sum$ is the rule for aggregating scores.



They are also referred to as evaluation criteria and may be further characterized by the development of sub-criteria, which ultimately produces an objectives hierarchy (also called a value hierarchy).

Performance Measures

Once the objectives are fully developed and the decision-maker(s) agree that they fully represent the important issues in the problem, performance measures are required to determine how well alternatives perform against the objectives. In Exhibit 1, performance measures are represented as scales beneath the objectives. Performance measures may be quantitative or qualitative, depending upon the objective and the availability of data for each measure.

Each performance measure is arithmetically transformed to a scale of zero-to-one. For example, if a cost scale ranging from $1,000 to $2,000 were converted to a zero-to-one scale, then $1,000 would rate a "one" on the new scale; $2,000 would rate a "zero;" and $1,500 would rate a 0.5. This zero-to-one scale described above shows a linear relationship between cost and value. This means that increasing cost from $1,000 to $1,500 is as important as increasing cost from $1,500 to $2,000. The two incremental changes are of equivalent value. Scales can also be nonlinear where changes along the scale have different degrees of importance.

Alternatives

Alternatives are the actions that may be taken to accomplish objectives. A well-considered value model includes a complete set of alternatives. Care must be taken not to exclude or overlook alternatives that might meet the stated objectives.

Alternatives are often the first components identified when evaluating infrastructure solutions. As soon as a need or problem is identified, alternatives come to mind. Typically, alternatives are identified, then the attributes are compared. It is important to re-examine alternatives generated this way after the objectives hierarchy is well-defined so that the important values can be used to define the alternatives, instead of the other way around.

Weighting Objectives

Based on the value system of the decision-maker(s), some objectives may be more or less important than other objectives. For example, loss of an ecosystem may be more important to a particular decision-maker than the cost to protect that ecosystem. Obviously, different stakeholders faced with the same problem may have different underlying value systems, and, therefore, may have a different sense of what's most important in the given problem.

This leads to the concept of "weighting" objectives. Assigning weights to objectives is a subjective exercise based on the values of the stakeholder(s). This is typically done in a workshop setting where a trained facilitator ensures that participants think clearly about the relative importance of different values. Weighting is done after the performance measures have been developed, so stakeholders can include in their consideration the extent to which the full set of alternatives vary in performance.

Weights may be assigned by allocating 100 points among the objectives (one of several methods). Weights are then converted to a 0-1 scale regardless of the method used to obtain weights.

Rating Alternatives and Aggregating Scores

Rating or scoring alternatives is the process by which the performance measurement scales are applied to the alternatives. This is essentially a weighted averaging process where scores are weighted by the value weights and summed for each alternative.

Interpreting Results

The results of any decision analysis are best regarded and applied as *decision aids*. Results should inform rather than dictate the decision. The analysis provides a way of organizing and comparing complex information. To the extent the decision-maker(s) believe that the structure of the value model represents the important issues, the weights and performance measures are appropriate, and the scores are accurate, they may be confident in the results.

It is also valuable to evaluate the model for sensitivity to weighting. If the results of the model do not change unless there are substantial changes in weights, then the decision-maker(s) may be confident in the results.

The Sewer Capacity Prioritization Value Hierarchy

The goal of the sewer capacity prioritization is to minimize capacity-related backups in the most cost-effective manner. The project team considered a number of different ways to structure a value hierarchy that would be consistent with the triple bottom line of financial, environmental, and social factors. It was decided that minimizing backups was a goal that incorporated many environmental and social objectives important to SPU management such as protecting public health, protecting the built and natural environment, and providing good service to customers. The project team considered whether or not all backups had similar negative consequences. Negative consequences result from backups that impact people and structures, and the available data from backups result from backup claims filed and the dollar value of those claims. This information was considered to be the best information that SPU has available at this time about the number and relative impact of backups.

After evaluating available data, the project team developed the value hierarchy shown in Exhibit 3 to represent the values important to minimizing the cost of addressing capacity-related backups. The heavily shaded boxes represent objectives that were quantified as part of this analysis.

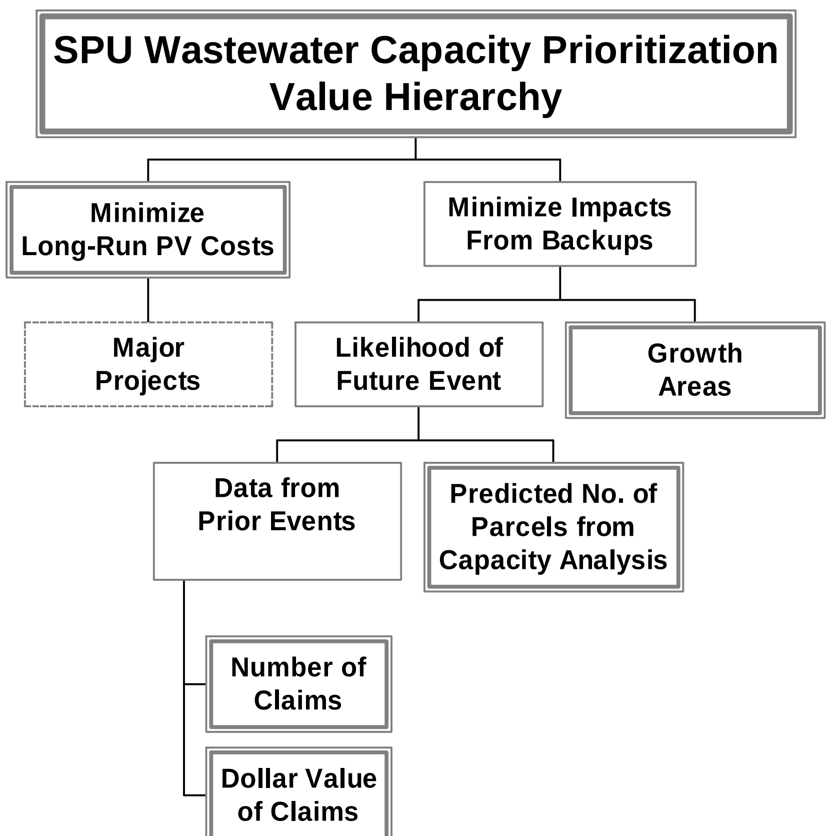


EXHIBIT 3
Value Hierarchy

As shown, the two primary objectives are to minimize the long-run present value of costs and to minimize impacts from backups. The long-run PV of costs is the capital costs associated with up-sizing pipes in areas with deficient capacity: at this level of analysis, no significant difference in operations and maintenance costs could be determined for the various at-risk areas. Another factor affecting costs is the potential that other major projects are scheduled for the same geographic area at some future date. In other words, if a major infrastructure project is planned in an area, such as a transportation or surface water project, there would be cost savings in coordinating the projects to minimize excavation and other common project elements. Major projects are shown as a dashed box in the value hierarchy, because data about major projects in the at-risk areas were not available at the time this report was published. SPU staff are currently gathering information to ensure that future projects are well coordinated. If another major infrastructure project is taking place in an at-risk area, that area will move at or near the top of the list of prioritized areas for further analysis because of the potential for cost savings.

The impacts from backups were further characterized in two ways: the likelihood of future backups, and the potential for an area to experience future growth in sewer capacity requirements.

Performance Scales and Scoring

This section identifies the data sources and methods used to assess the relative performance of each objective in meeting the prioritization goal, and reports on how each objective was measured for each at-risk area.

Cost Estimates

Estimated capital costs in 2005$ for each at-risk area and service level are shown in Exhibit 4. As discussed in Chapter 7, the capital costs were estimated assuming that only capacity deficient pipes would be replaced. It was assumed that each pipeline would be replaced with a larger diameter pipe and that the replacement would be done using open-cut construction.

Number and Amount of Reported Claims

The number and amount of reported claims for each at-risk area is shown in Exhibit 5. The data are taken from SPU records since 1986. It should be noted that the claims data shown were not necessarily claims that were paid. For example, a number of the claims were made for storms that were high-intensity, short-duration rainfall events that exceed the SPU level of service. In a September 23, 2005 meeting with the project Core Team, it was suggested that it might be of interest to conduct the prioritization counting only claims paid or excluding the claims associated with storm intensities that exceed SPU's level of service. This would be another way of looking at the dollar value of claim data in the analysis.

Another idea suggested during the Core Team meeting was to consider weighting repeat claims more heavily than claims from a single backup occurrence. These other ways of evaluating claim data would require a more in-depth analysis of SPU’s backup data, but may be a worthwhile future exercise to refine the prioritization.

EXHIBIT 4

Cost Estimates for At-Risk Areas (Million 2005$)

	Level of Service			
At-Risk Area	**2-Year**	**5-Year**	**10-Year**	**20-Year**
1	$0.34	$0.68	$0.91	$1.09
2	$3.63	$4.66	$5.18	$5.75
3	$0.19	$0.24	$0.27	$0.51
4	$0.00	$0.00	$0.00	$0.39
5	$1.02	$1.41	$1.72	$1.88
6	$1.27	$2.59	$3.74	$4.93
7	$3.08	$3.47	$3.85	$4.84
8	$2.84	$5.67	$7.58	$9.73
9	$0.57	$1.04	$1.35	$1.42
10	$0.24	$0.81	$1.25	$1.81
11	$2.18	$3.76	$4.83	$6.03
12	$0.55	$0.80	$0.83	$0.86
13	$1.67	$3.64	$5.54	$7.25
14	$0.00	$0.12	$0.12	$0.25
15	$1.42	$1.97	$2.41	$3.31
16	$2.70	$3.21	$3.77	$4.15
17	$2.07	$2.55	$3.23	$4.49
18	$0.01	$0.05	$0.05	$0.08
19	$0.13	$0.21	$0.23	$0.33

EXHIBIT 5

Number and Amount of Claims

At-Risk Area	No of Claims	Amount of Claims
1	0	$0
2	9	$22,002
3	1	$0
4	0	$0
5	0	$0
6	26	$64,105
7	1	$3,500
8	23	$138,122
9	13	$23,025
10	5	$5,875
11	48	$95,306
12	9	$16,368
13	18	$86,481
14	4	$207,209
15	5	$300
16	7	$25,114
17	6	$201
18	0	$0
19	1	$27,894

During that Core Team meeting it was also suggested that the number of ***reported*** backups does not necessarily correspond to the actual number of backups because not all backups are reported to SPU. It was also suggested that backups might be under-reported in low income areas. This possibility was investigated and is reported on below under the heading the Likelihood of Not Reporting.

Number of At-Risk Parcels from Capacity Analysis

The number of parcels at-risk of experiencing backups from the capacity analysis is shown in Exhibit 6. The first set of data represents the total number of at-risk parcels for each level of service. The methodology used to estimate this information is described in Section 6. The second set of data, called Weighted Parcels, represents the number of at-risk parcels in any one year. In other words, the number for the two-year level of service is calculated by dividing the number of at-risk parcels by two. The number for the five-year level of service takes the increase from the two-year to the five year level of service, divides that by five and adds that to the two year weighted total.

EXHIBIT 6
Number of Parcels from Capacity Analysis

At-Risk	Number of Parcels				Weighted Parcels			
Area	2-yr	5-yr	10-yr	20-yr	2-yr	5-yr	10-yr	20-yr
1	32	68	117	131	16	23	28	29
2	157	212	252	268	79	90	94	94
3	164	164	164	164	82	82	82	82
4	0	0	0	0	0	0	0	0
5	135	179	191	191	68	76	78	78
6	11	21	36	40	6	8	9	9
7	30	34	38	38	15	16	16	16
8	101	135	168	195	51	57	61	62
9	49	65	88	106	25	28	30	31
10	0	39	39	40	0	8	8	8
11	370	495	619	728	185	210	222	228
12	14	20	20	20	7	8	8	8
13	77	96	110	123	39	42	44	44
14	0	12	12	12	0	2	2	2
15	145	158	164	178	73	75	76	76
16	154	160	170	172	77	78	79	79
17	600	640	647	650	300	308	309	309
18	16	16	16	16	8	8	8	8
19	0	4	4	39	0	1	1	3

Areas of Future Growth

Areas of future sewer capacity growth are shown in Exhibit 7 for each at-risk area and level of service. GIS analysis and growth designations in the Seattle Comprehensive Plan were used to estimate the number of acres with low, medium, high, and very high need for future sewer capacity. As shown in the notes to Exhibit 7, those designations were used to represent estimated gallons per day of increased sewer flows. The Growth Area Index is the sum of the products of acres of growth and gallons per day for each of the four levels of need. The Growth Area Index was used to represent the relative intensity of future sewer capacity needs in each area.

During the Core Team meeting it was noted that land use changes should not appreciably affect capacity in combined areas, assuming the drainage ordinance is enforced in the future.

EXHIBIT 7
Calculation of Areas of Future Growth

At-Risk Area	Growth Area Index	Growth Area (acres)			
		Low	Medium	High	Very High
1	4,519	18	0	0	0
2	29,176	117	0	0	0
3	7,069	28	0	0	0
4	2,339	9	0	0	0
5	22,276	82	2	0	0
6	568,008	0	20	144	66
7	196,361	0	0	9	45
8	1,006,954	20	0	50	226
9	30,380	20	30	2	0
10	18,194	73	0	0	0
11	105,657	302	39	0	0
12	62,773	0	24	22	0
13	448,839	75	12	85	62
14	2,210	9	0	0	0
15	51,322	205	0	0	0
16	36,952	148	0	0	0
17	72,899	292	0	0	0
18	2,479	10	0	0	0
19	3,064	12	0	0	0

Notes:
Growth areas are determined based on their relative increase of baseflow (gpd) per acre:

	Actual Range	Measure Used	
Low:	<500 gpd/ac	250	gpd/ac
Medium:	<1000 gpd/ac	750	gpd/ac
High:	<3000 gpd/ac	2000	gpd/ac
Very High:	>3000 gpd/ac	4000	gpd/ac

Weighting the Relative Importance of Objectives

As discussed in the Value Modeling Overview above, a key step in the value modeling process is to weight the relative importance of the measured objectives. Weights were initially assigned by the project team and then refined during the September 23, 2005 Core Team meeting.

At the meeting, the Core Team went through a facilitated process to assign weights to objectives. Weights indicate the relative importance of each objective using the perspective of SPU management. The weights were determined through a voting process in which each team member was asked to assume that he or she had $100 to spend, and was asked to spend the dollars on objectives in such a manner that represented the relative importance of each objective. The weighting was done for different levels of the value hierarchy which resulted in weighting the following objectives against each other:

- Likelihood of future event versus growth areas
- Data from prior events versus the results from the capacity analysis
- The number of claims versus the dollar value of claims

The initial weights of individual team members were discussed and team members were asked to explain their rationale for their weightings. Team members then voted a second time which provided them the opportunity to change their weights after considering other perspectives about the objectives. The final weights that resulted from this process are shown in Exhibit 8. The weights were a consensus of the weights of the project team members that team members were generally comfortable with as representing the values of SPU management. However, as shown in Exhibit 8, the maximum, minimum, and standard deviation of the selected weights indicate that there was a wide difference in opinion about the relative importance of the weights. Thus sensitivity analysis was conducted to investigate the extent to which different prioritizations might result from different weightings. The results of the sensitivity analysis are discussed in the last section of this memorandum.

EXHIBIT 8
Weights for Prioritization Objectives

	Weight	Max	Min	Standard Deviation
Likelihood of Future Event	75	90	50	13.3
Growth Areas	25	50	10	13.3
Subtotal	100			
Data from Prior Events	65	90	30	20.1
No. of Parcels	35	70	10	20.1
Subtotal	100			
Number of Claims	65	90	10	23.8
Dollar Value of Claims	35	90	10	23.8
Subtotal	100			

Likelihood of Not Reporting

During the September 23, 2005 Core Team meeting it was suggested that lower income households may be less likely to file a backup claim than other City residents would be. Thus socioeconomic data from at-risk areas was analyzed to investigate this effect and adjust the backup claim and dollar value of claim data accordingly.

The methodology for this analysis consisted of calculating various socioeconomic data for each at-risk area using census block information from the 2000 Census. A GIS analysis was done to identify those block groups that best matched the geographic boundaries of the at-risk areas.

In this analysis, we developed the term and measure the "Likelihood of Not Reporting (LNR)" to represent the potential under-reporting of backups in low income areas. The available data was analyzed and the following two metrics that were best felt to represent the LNR:

- the percent of households living in poverty
- the percent of households that are linguistically isolated (Linguistically isolated means households for which all adults have some limitations in communicating in English.)

Exhibit 9 shows the base data used in this analysis including the block groups included in each at-risk area, the percent of households living in poverty, and the percent of households linguistically isolated. The data are shown for each block group and the average for each at-risk area is shown as well.

To measure how the LNR might affect the number and amount of claims, we expressed the LNR in the value model by multiplying the ("Number of Claims" + "Amount of Claims") times (1 + the LNR) times (Sensitivity Factor). The sensitivity factor allows us to test various possible relationships between the LNR and prioritization of capacity areas. When the sensitivity is set to one, then the number of claims and the amount of claims are increased by the percent of HH living in poverty and the percent of HH that are linguistically isolated. Exhibit 10 shows how the LNR affects the number and dollar value of claims for a sensitivity value of two.

After reviewing the results, we found that the value model results were not affected significantly with an LNR sensitivity of 1. Therefore, we tested the sensitivity of claims to the LNR by using sensitivities of 1, 2, 5, and 10. In the opinion of the project team, a sensitivity of one or two seems plausible: a sensitivity of 10 seems rather unrealistic. Exhibit 11 shows the value scores for each at-risk area for the different sensitivities. As shown, the results do not change much at all with sensitivity factors of 1 and 2, and even at the rather extreme sensitivity factor of 10, there is relatively little change in the rank order of at-risk areas.

After viewing the sensitivity results, we settled on a LNR sensitivity factor of two for the prioritization model.

Prioritization Results

The at-risk areas were prioritized by calculating a total value-cost score for each area at the four levels of service. The value scores were calculated using a weighted average of scores and weights for each area normalized to a scale of 0 to 1. The scores were normalized by taking the maximum and minimum score over the 19 areas and dividing the score for an area by the difference between the maximum and minimum scores for all areas. For example, the LNR-adjusted number of claims ranged from 0 to 64.4. An area with 16.1 LNR-adjusted claims would receive a score of 0.25, and an area with 32.2 LNR-adjusted claims would receive a score of 0.5.

EXHIBIT 9

Base Socioeconomic Data for Calculating the Likelihood of Not Reporting

At-Risk Area	Block Group	Percent Below Poverty	Percent Linguis-tically Isolated
1	530330005001	5.82	2.63
1	530330005003	4.22	0.00
Subtotal 1		5.06	1.39
2	530330004023	1.80	7.57
2	530330014006	0.00	1.53
2	530330014001	6.46	2.07
2	530330014002	19.60	1.66
2	530330014003	4.97	5.77
2	530330017001	8.98	1.00
Subtotal 2		6.54	3.71
3	530330031007	4.47	0.00
3	530330031008	1.53	1.75
3	530330031004	7.78	2.31
Subtotal 3		4.30	1.38
4	530330030005	0.00	0.00
4	530330030004	6.34	0.00
Subtotal 4		2.98	0.00
5	530330018002	9.35	2.34
5	530330028001	4.41	0.00
5	530330027006	6.01	3.18
5	530330027005	1.74	0.00
5	530330028002	4.37	1.94
Subtotal 5		5.66	1.50
6	530330071001	11.60	3.13
6	530330070003	5.60	0.85
6	530330067002	3.86	0.00
6	530330070005	7.50	1.34
6	530330070002	5.14	2.28
6	530330071002	7.69	3.63
Subtotal 6		6.86	1.90
7	530330080013	14.76	6.25
7	530330080022	16.41	6.05
Subtotal 7		15.64	6.15
8	530330073001	30.63	4.05
8	530330073003	39.26	14.81
8	530330072001	11.28	2.13
8	530330074007	6.73	2.34
8	530330074006	10.81	0.54
8	530330074003	6.42	1.71
8	530330074005	23.96	6.35
8	530330073002	18.32	3.37
8	530330074004	20.35	8.58
8	530330082001	5.99	10.14
Subtotal 8		16.06	4.58
9	530330066001	5.42	2.43
9	530330065004	3.43	2.15
9	530330065003	11.39	1.78
Subtotal 9		6.04	2.12

At-Risk Area	Block Group	Percent Below Poverty	Percent Linguis-tically Isolated
10	530330062003	0.00	0.00
10	530330064002	7.19	1.35
10	530330064004	2.56	1.83
Subtotal 10		3.87	1.09
11	530330063004	5.37	0.00
11	530330077001	2.29	4.20
11	530330077005	5.59	1.60
11	530330078007	0.96	2.57
11	530330076002	31.87	0.00
11	530330077004	5.67	4.70
11	530330077002	13.55	2.56
11	530330079001	21.25	0.00
11	530330077003	14.18	1.55
11	530330088005	14.92	0.00
Subtotal 11		12.54	1.88
12	530330075002	11.30	1.26
12	530330075004	20.84	7.84
12	530330079002	14.18	11.90
12	530330079004	17.45	5.58
12	530330079003	15.37	0.00
Subtotal 12		15.76	5.07
13	530330081002	58.51	9.96
13	530330081001	20.30	4.70
13	530330092002	29.25	12.24
13	530330093002	10.00	0.00
Subtotal 13		29.76	6.95
14	530330099001	4.40	1.34
14	530330098002	4.29	0.00
Subtotal 14		4.35	0.72
15	530330099002	7.11	7.78
15	530330108003	7.48	11.90
15	530330107001	16.59	9.64
Subtotal 15		11.13	9.35
16	530330114001	8.73	7.26
16	530330114002	12.74	5.85
16	530330114003	13.22	17.97
16	530330114005	20.46	1.53
Subtotal 16		13.36	7.77
17	530330112002	12.19	17.19
17	530330112003	12.67	15.59
Subtotal 17		12.48	16.21
18	530330117002	11.99	22.70
Subtotal 18		11.99	22.70
19	530330110002	36.16	17.98
19	530330117003	13.43	16.67
19	530330117001	23.80	25.86
Subtotal 19		25.26	20.16

Source: U.S. Census.

EXHIBIT 10

Adjusting No. and Amount of Claims by the Likelihood of Not Reporting (LNR)

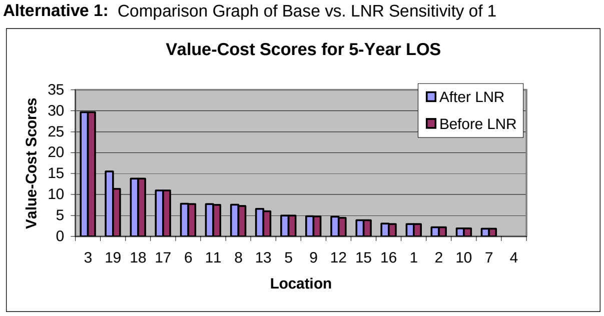
Sensitivity Factor = 2

	After LNR is Applied		Before LNR is Applied		
At-Risk Area	No of Claims	Amount of Claims	No of Claims	Amount of Claims	Likelihood of Not Reporting
1	1.1	$0	1	$0	6.5%
2	10.8	$26,511	9	$22,002	10.2%
3	1.1	$0	1	$0	5.7%
4	1.1	$0	1	$0	3.0%
5	0.0	$0	0	$0	7.2%
6	37.6	$75,336	32	$64,105	8.8%
7	2.9	$5,025	2	$3,500	21.8%
8	32.5	$195,162	23	$138,122	20.6%
9	17.5	$26,786	15	$23,025	8.2%
10	7.7	$6,459	7	$5,875	5.0%
11	64.4	$122,789	50	$95,306	14.4%
12	14.2	$23,188	10	$16,368	20.8%
13	32.9	$149,976	19	$86,481	36.7%
14	5.5	$228,231	5	$207,209	5.1%
15	8.5	$423	6	$300	20.5%
16	10.0	$35,729	7	$25,114	21.1%
17	14.2	$316	9	$201	28.7%
18	1.7	$0	1	$0	34.7%
19	3.8	$53,236	2	$27,894	45.4%

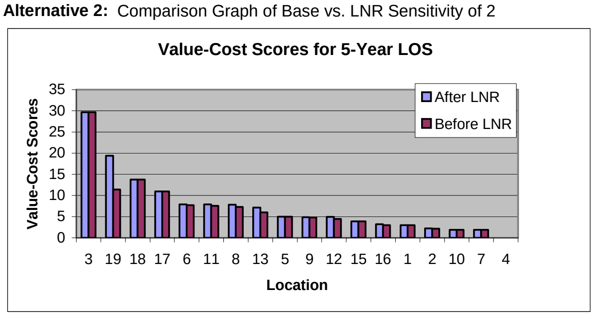
EXHIBIT 11

Prioritization with LNR Sensitivities Ranging from 1 to 10

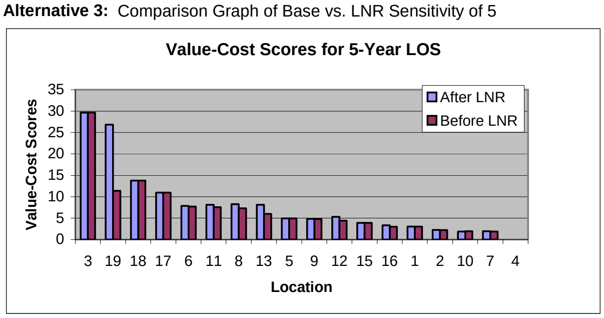
Alternative 1: Comparison Graph of Base vs. LNR Sensitivity of 1



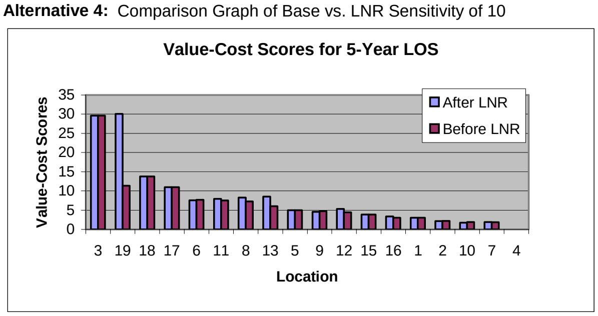
Alternative 2: Comparison Graph of Base vs. LNR Sensitivity of 2



Alternative 3: Comparison Graph of Base vs. LNR Sensitivity of 5



Alternative 4: Comparison Graph of Base vs. LNR Sensitivity of 10



The scores were weighted using the weights shown in Exhibit 8 using the following formula:

$$0.75 \times ((0.65 \times (0.65 \times No.ofClaims + 0.35 \times DollarValueofClaims)) + (0.35 \times No.ofParcelsfromCapacityAnalysis)) + 0.25 \times GrowthAreaIndex$$

The value-cost score was calculated by multiplying the value score by 100 and dividing by cost (in millions of dollars). The resulting value-cost scores for each level of service are shown in Exhibit 12. The rank order of at-risk areas for each level of service is shown in Exhibit 13.

Sensitivity Analysis

Recognizing that there was some difference of opinion amongst the core team on the choice of weights for each objective, sensitivity analysis was conducted to test how the results would change with changes in weights. To test this sensitivity, we re-evaluated the results using the individual weights that were most different from the group average from the September 23 meeting. We refer to these values as "extreme weights". In other words, the sensitivity analysis examines the maximum change in the ranking of at-risk areas that would result from any core team member's individual views about the relative importance of the objectives.

The results of the sensitivity analysis are shown in Exhibit 14. The first two rows of numbers show the base weights and the extreme weights. For example, for the likelihood of future backup and growth areas, the base weights were 75/25 and the extreme weights tested are 90/10 and 50/50. In general, the results are relatively stable, and not particularly sensitive to changes in weighting. Even with this testing of extreme weights, the rank of most at-risk areas remain in the general vicinity of the ranking that results from the base weights.

Some observations about the results follow:

- The greatest change in ranking from the base weighting occurred when prior events and number of parcels from the capacity analysis were weighted 90/10 instead of 65/35. With this weighting, 9 of the 19 at-risk areas moved up or down more than 3 places. The greatest change was in area 17 which moved 6 places, from a rank of 5 to a rank of 11.
- The next most sensitive rankings were when the likelihood of future backups and growth areas were weighted 50/50 instead of 75/25, and when prior events and the number of parcels from the capacity analysis were weighted 30/70 instead of 65/35. In both of these cases, 5 of the 19 at-risk areas moved up or down more than 3 places.
- The at-risk areas with rankings that changed the most places were:
  - Areas 17, up or down a total of 20 places in the 6 sensitivities
  - Area 6, up or down a total of 16 places in the 6 sensitivities

EXHIBIT 12
Prioritization of Capacity Investments by Level of Service

2-Year LOS

At-Risk Area	Value	Cost	Value-Cost Score
18	0.007	$0.01	70.7
3	0.073	$0.19	38.4
19	0.040	$0.13	30.8
6	0.202	$1.27	15.9
8	0.440	$2.84	15.5
13	0.257	$1.67	15.4
17	0.280	$2.07	13.5
11	0.279	$2.18	12.8
9	0.048	$0.57	8.5
12	0.039	$0.55	7.0
5	0.064	$1.02	6.3
15	0.076	$1.42	5.4
1	0.015	$0.34	4.3
16	0.103	$2.70	3.8
10	0.009	$0.24	3.7
2	0.095	$3.63	2.6
7	0.065	$3.08	2.1
4	0.000	$0.00	0.0
14	0.171	$0.00	0.0

5-Year LOS

At-Risk Area	Value	Cost	Value-Cost Score
14	0.173	$0.12	143.9
3	0.071	$0.24	29.6
19	0.041	$0.21	19.4
18	0.007	$0.05	13.8
17	0.280	$2.55	11.0
11	0.297	$3.76	7.9
6	0.203	$2.59	7.9
8	0.445	$5.67	7.8
13	0.259	$3.64	7.1
5	0.070	$1.41	5.0
12	0.039	$0.80	4.9
9	0.051	$1.04	4.9
15	0.077	$1.97	3.9
16	0.102	$3.21	3.2
1	0.020	$0.68	3.0
2	0.103	$4.66	2.2
10	0.015	$0.81	1.9
7	0.066	$3.47	1.9
4	0.000	$0.00	0.0

10-Year LOS

At-Risk Area	Value	Cost	Value-Cost Score
14	0.173	$0.12	143.9
3	0.071	$0.27	26.3
19	0.041	$0.23	17.7
18	0.007	$0.05	13.7
17	0.280	$3.23	8.7
11	0.307	$4.83	6.3
8	0.447	$7.58	5.9
6	0.205	$3.74	5.5
12	0.039	$0.83	4.7
13	0.260	$5.54	4.7
5	0.071	$1.72	4.1
9	0.053	$1.35	3.9
15	0.077	$2.41	3.2
16	0.103	$3.77	2.7
1	0.024	$0.91	2.7
2	0.106	$5.18	2.0
7	0.066	$3.85	1.7
10	0.015	$1.25	1.2
4	0.000	$0.00	0.0

20-Year LOS

At-Risk Area	Value	Cost	Value-Cost Score
14	0.173	$0.25	69.1
3	0.071	$0.51	13.9
19	0.042	$0.33	12.8
18	0.007	$0.08	8.6
17	0.280	$4.49	6.2
11	0.311	$6.03	5.2
8	0.449	$9.73	4.6
12	0.039	$0.86	4.6
6	0.205	$4.93	4.2
5	0.071	$1.88	3.8
9	0.053	$1.42	3.8
13	0.261	$7.25	3.6
16	0.103	$4.15	2.5
15	0.077	$3.31	2.3
1	0.025	$1.09	2.3
2	0.107	$5.75	1.9
7	0.066	$4.84	1.4
10	0.015	$1.81	0.9
4	0.000	$0.39	0.0

EXHIBIT 13
Prioritized Order of At-Risk Areas for Capacity Investment

	Level of Service			
Rank	**2-yr**	**5-yr**	**10-yr**	**20-yr**
1	18	14	14	14
2	3	3	3	3
3	19	19	19	19
4	6	18	18	18
5	8	17	17	17
6	13	11	11	11
7	17	6	8	8
8	11	8	6	12
9	9	13	12	6
10	12	5	13	5
11	5	12	5	9
12	15	9	9	13
13	1	15	15	16
14	16	16	16	15
15	10	1	1	1
16	2	2	2	2
17	7	10	7	7
18	4	7	10	10
19	14	4	4	4

EXHIBIT 14
Sensitivity Analysis: Rank Order of At-Risk Areas with Extreme Weights (5-Year LOS)

		Rank Order with Level 1 Weights				Rank Order with Level 2 Weights				Rank Order with Level 3 Weights			
At-Risk Area	Base Weights	Likeli-hood of Future Backup	Growth Areas	Likeli-hood of Future Backup	Growth Areas	Prior Events	No. of Parcels	Prior Events	No. of Parcels	No. of Claims	Dollar Value of Claims	No. of Claims	Dollar Value of Claims
Base Weights		75	25	75	25	65	35	65	35	65	35	65	35
Test Sensitivity of:		**90**	**10**	**50**	**50**	**90**	**10**	**30**	**70**	**90**	**10**	**10**	**90**
1	15	15		16		18		13		14		15	
2	16	16		18		17		16		16		16	
3	2	2		2		3		2		2		3	
4	19	19		19		19		19		19		19	
5	10	9		12		13		6		9		12	
6	7	11		4		4		10		5		8	
7	18	18		14		14		18		17		18	
8	8	8		5		5		8		7		6	
9	12	5		11		10		12		12		11	
10	17	17		17		16		17		18		17	
11	6	6		9		7		5		6		7	
12	11	12		10		8		15		13		10	
13	9	7		7		6		11		10		5	
14	1	1		1		1		1		1		1	
15	13	13		13		15		9		11		14	
16	14	14		15		12		14		15		13	
17	5	10		8		11		4		4		9	
18	4	4		6		9		3		3		4	
19	3	3		3		2		7		8		2	

SEATTLE PUBLIC UTILITIES
WASTEWATER SYSTEMS PLAN

APPENDIX J

SEPA CHECKLIST

SEATTLE PUBLIC UTILITIES

ENVIRONMENTAL CHECKLIST

A. BACKGROUND

A1. Name of proposed project, if applicable:
City of Seattle Wastewater Systems Plan

A2. Name of applicant:
Seattle Public Utilities

A3. Address and phone number of applicant and contact person:
Martha Burke, Project Manager
Seattle Public Utilities
700 Fifth Avenue, Suite 4900
Seattle, WA 98104-5004
206-684-7686

A4. Date checklist prepared:
December 29, 2005

A5. Agency requesting checklist:
Seattle Public Utilities

A6. Proposed timing or schedule (including phasing, if applicable):
Seattle Public Utilities (SPU) has developed the *Wastewater Systems Plan* to guide the maintenance and improvement of the Seattle wastewater system over the next 20 years. Implementation of the proposed plan would be phased. Some elements of the plan would be implemented immediately. Others would be implemented in future years.

A7. Do you have any plans for future additions, expansion, or further activity related to or connected with this proposal?
SPU engages in a number of wastewater activities, including planning, engineering, operation, maintenance, financial planning, and customer service. SPU will continue to focus on programs and initiatives to address wastewater capital and operational needs. SPU will periodically review and update the *Wastewater Systems Plan*, as needed, such as developing new wastewater policies, evaluating cost-effective operations and maintenance (O&M) practices, and identifying capital improvement projects. Individual projects and more specific program choices would be determined through periodic reviews by SPU as well as the annual City budget process. All programs and projects must be included in a Council-approved capital improvement program and undergo internal review by SPU's Asset Management Committee before being approved for implementation.

Other local and regional planning initiatives could have an effect on the development and implementation of the *Wastewater Systems Plan*. The past and current wastewater-related planning efforts are described in detail in Chapter 2 of the *Wastewater Systems Plan*.

In addition to this *Wastewater Systems Plan*, SPU has recently completed or is currently working on a number of other plans, projects, and programs that relate to SPU's wastewater collection system. These include the Drainage and Wastewater 2005-2010 Capital Improvement Program, SPU's *Comprehensive Drainage Plan*, SPU's CSO-control program, and SPU's asset management initiative,

As required by Washington's Growth Management Act (GMA), the City has prepared and adopted Seattle's *Comprehensive Plan*, which was last updated in 2004. The *Comprehensive Plan* contains policies on utilities and identifies areas for future growth, which have been sources of direction for SPU's wastewater planning. As future amendments to the *Comprehensive Plan* are proposed and adopted, SPU would continue to evaluate its programs and policies for consistency with the *Comprehensive Plan*.

A8. List any environmental information you know about that has been prepared, or will be prepared, directly related to this proposal.

A large body of existing scientific and environmental information, comprising published and unpublished data, analyses, and literature, provided a scientific basis for the analysis and development of the *Wastewater Systems Plan*. Census data were used to identify areas of Seattle that are socially less likely to call or report sewer backups, such as areas with low income or that do not speak English.

SPU also prepared extensive environmental information for its *2001 Combined Sewer Overflow Reduction Plan Amendment*. The City issued the Draft Environmental Impact Statement (DEIS) in August 2001 and the Final Environmental Impact Statement (FEIS) in November 2001. The DEIS and FEIS together provide a focused, programmatic review of existing conditions, potential impacts, and mitigation measures associated with implementation of the *CSO Reduction Plan*. Key areas of environmental information included impacts and benefits for water quality and aquatic resources, including threatened and endangered species; construction and operation impacts on transportation and public services; air emissions; odor and noise in the vicinity of CSO facilities; and impacts on public use of parks and beaches. The Draft and Final Environmental Impact Statements for the *2001 Combined Sewer Overflow Reduction Plan Amendment* are incorporated by reference into this SEPA Environmental Checklist.

The City has obtained its renewed National Pollutant Discharge Elimination System (NPDES) Permit for the Seattle CSO system and outfalls, which became effective on December 1, 2005. The NPDES Permit includes a CSO Supplemental Characterization Study, which is a monitoring program that would measure conventional and priority pollutants in CSO overflows. The City’s NPDES Permit and its approval process included technical and public review of applicable environmental information.

A9. Do you know whether applications are pending for governmental approvals <u>of other proposals</u> directly affecting the property covered by your proposal? If yes, explain.

The *Wastewater Systems Plan* is a planning document, and specific wastewater projects are not proposed under the plan. Future wastewater projects to implement the *Wastewater Systems Plan* would occur throughout the City. Specific proposals in the immediate vicinity of future wastewater project sites cannot be determined at this time. Any applications for other proposals that could affect future wastewater facilities would be assessed when individual wastewater projects are implemented. Local and regional planning proposals that could affect the *Wastewater Systems Plan* are identified in Section A7 above.

The Washington State Department of Transportation (WSDOT), in partnership with the City of Seattle and the Federal Highway Administration (FHWA), are proposing a replacement project for the existing Alaskan Way Viaduct/Seawall. This proposed project would be within the geographic boundaries of the City of Seattle, covered by this *Wastewater Systems Plan*. The Alaskan Way Viaduct/Seawall Replacement Project would affect the existing drainage and wastewater systems in the project area. A project-specific SDEIS is being prepared for the Alaskan Way Viaduct/Seawall Replacement Project with WSDOT and FHWA as lead agencies. The replacement of the existing wastewater and drainage system in the Alaskan Way Viaduct/Seawall project area would not have a net adverse environmental impact. Other specific proposals in the vicinity of future wastewater project sites cannot be determined at this time.

A10. List any government approvals or permits that will be needed for your proposal, if known.

The Seattle City Council would review and pass a resolution to approve the *Wastewater Systems Plan*. The *Wastewater Systems Plan* is a planning document that does not identify individual projects, therefore specific project-level permits and approvals cannot be determined at this time. Site-specific permits and approvals would be identified when individual wastewater projects are implemented. Future programs and projects that would result from the *Wastewater Systems Plan* must comply with applicable federal, state, and local regulations. On a project-by-project basis, Capital Improvement Projects (CIP) that implement the *Wastewater Systems Plan* would require certain federal, state, and local government approvals and permits, including SEPA review as applicable, before any future project may proceed. Depending on the timing and geographical association of future individual projects, two or more projects may be evaluated under one SEPA document. Future wastewater projects also would obtain all applicable permits and approvals.

A11. Give brief, complete description of your proposal, including the proposed uses and the site of the project. There are several questions later in this checklist that ask you to describe certain aspects of your proposal. You do not need to repeat those answers on this page. (Lead agencies may modify this form to include additional specific information on project description.)

Seattle Public Utilities (SPU) manages the City of Seattle's wastewater system. SPU has prepared the *Wastewater Systems Plan*, which addresses the key capital and operational needs over the next 20 years and describes the programs and initiatives that would be delivered over that time. The proposed programs and strategies are described in detail in the accompanying *Seattle Public Utilities Wastewater Systems Plan*, December 2005.

The *Seattle Public Utilities Wastewater Systems Plan* is available on the SPU website, at www.seattle.gov/util. All figures referenced in this Checklist also are available in the Plan on the SPU Website.

The *Wastewater Systems Plan* evaluates two primary SPU program areas:

1. Wastewater Collection & Conveyance: The wastewater collection and conveyance program concerns the City's network of sewer collection pipes,

pump stations, and sewer force mains that collect and convey wastewater to King County interceptors for treatment and disposal at County wastewater treatment facilities. The program's mission is reliable collection and conveyance of wastewater and combined sewage for the protection of public health, safety, and property. Its primary goal is the prevention and response to sewer backups or overflows.

2. Combined Sewer Overflow (CSO) Control: CSOs are discharges of untreated wastewater and stormwater from the City's combined sewers directly into marine waters, lakes, or rivers during periods of heavy rainfall. Although the sewage in CSOs is greatly diluted by stormwater, CSOs may potentially be harmful to public health, water quality, aquatic life, and public beaches because of bacteria and chemicals present in the sewage and stormwater runoff. The goals of the SPU CSO control program are to reduce CSO occurrences, improve water quality, and meet state permit and regulatory requirements.

The most substantial needs facing SPU's wastewater system over the next 20 years include renewal of aging infrastructure, reduction of future sewer backups, and CSO control. The existing and future needs and risks are described in detail in Chapter 6 of the *Wastewater Systems Plan*.

The SPU network of pipelines and pump stations is growing older. Aging infrastructure could lead to structural failure, increased maintenance costs, groundwater infiltration, backups, and potential collapses. SPU needs to renew or replace (R&R) some of its old gravity sewers, pump stations, and force mains before they fail.

A sewer backup is a blockage or other condition that causes wastewater to enter a basement or overflow to ground surface. Approximately an average of 800 backups occur annually in Seattle, of which 90 percent are attributable to a problem with the property owner's side sewer that has clogged or collapsed. Of the approximately 80 annual backups associated with the SPU sewer mains, the backups are the result of maintenance problems (blockage), insufficient capacity, or sewer failure.

CSO discharges are discharges of untreated wastewater and rainwater that occur following severe rainstorms, when the volumes of stormwater runoff exceed the capacity of the pipelines or pump stations. Seattle's CSO discharges currently are allowed under the City's National Pollutant Discharge Elimination System (NPDES) permit. The Washington State Department of Ecology (Ecology), who issues the NPDES permit, has adopted regulations limiting the number of CSO discharges to an average of not more than one overflow event per year per CSO outfall. The City prepared its most recent CSO Reduction Plan in 2001, which focuses on eight priority basins (see Figure 6-3 of the *Wastewater Systems Plan*). Generally, the needs for these basins include increased maintenance and/or increased storage to detain CSO discharges.

Failure to meet the needs of SPU's wastewater collection and conveyance and CSO control programs could result in environmental and human health risks. Sanitary sewage or CSOs could be discharged into the environment, which could have adverse impacts on water quality, aquatic habitat, biological and natural resources, and use of public beaches. Sewage could backup into people's houses, which could adversely affect human health and damage property. Public streets could be affected by sewage overflows and unplanned sewer repairs.

Objectives

To meet the needs of reducing future sewer backups and CSO discharges, the *Wastewater Systems Plan* identifies and describes several levels of service. Development of the levels of service options and recommendations are discussed in detail in Chapter 7 of the *Wastewater Systems Plan*. The proposed levels of service for sewer backups, drainage in combined sewer areas, and CSOs are presented in Table 1:

Table 1: Wastewater Collection and Conveyance Program Levels of Service

Service Category	Service Level Objective	Service Level Target	Cost to Achieve
Effective Conveyance (Backups)	• Customers in all areas of the City shall be well served by the SPU sewer system, and should not experience frequent sewer backup. • The overall number of backups caused by the SPU sewer system shall not increase.	• By 2020, no more than one backup in 5 years, on average, at any location, caused by a problem with the SPU sewer system. • No more than 80 maintenance-related backups per year, on average, systemwide.	$36.9 million
Flooding in Combined Sewer Areas	• Customers in combined sewer areas of the City shall be served so that surface flooding on public roads or streets does not occur frequently.	• Flooding in the right-of-way no more than once in 5 years, on average.	Included in cost to achieve effective conveyance (backups) service level
Combined Sewer Overflows (CSOs)	• SPU's combined sewer system shall meet the overflow limits required by its NPDES permit and state and federal CSO regulations.	• By 2020, CSOs shall be limited to an average of not more than one untreated discharge per CSO outfall per year.	$199 million
Problem Response	• SPU shall respond quickly and effectively to problems with potential health consequences.	• 80% of high priority problems responded to within 1 hour. • 80% of high priority problems have service reinstated within 4 hours.	N/A

Most areas of the City already achieve a higher level of service for sewer backups, and 96 percent of SPU customers would probably never experience a sewer backup except following a major storm/flood event that occurs less often than once in 20 years. The proposed service level for CSOs is based on state regulations that require SPU to limit CSO discharges to an average of not more than one untreated discharge per CSO outfall per year by 2020.

Proposal

To achieve the recommended levels of service, SPU proposes to implement programs and strategies for wastewater collection and conveyance and for CSO control. As part of the wastewater plan development, SPU analyzed various alternatives to arrive at recommendations for the most cost-effective strategies. The proposed strategies and their implementation are described in Chapters 8 and 9 of the *Wastewater Systems Plan*. The recommended strategies proposed in the *Wastewater Systems Plan* are summarized below.

Sewer Maintenance and Rehabilitation: Sewer maintenance and rehabilitation activities would focus on preventing maintenance-related sewer backups and on repairing or replacing deteriorating sewer pipes to prevent sewer collapses. Sewer maintenance strategies would reduce the number of backups by improving crew efficiency, increasing proactive maintenance activities, and adding a proactive grease abatement program. The sewer renewal and replacement (R&R) program would mitigate anticipated failures of the City's aging gravity sewer pipelines.

Sewer Capacity Improvements: SPU would launch a capital program to address capacity deficiencies. SPU would focus on the areas with the highest risk of having capacity deficiencies, including areas with histories of storm-related sewer backups, capacity deficiencies identified by hydraulic modeling, and areas with future growth potential. SPU also would focus on areas based on socioeconomic data for determining the likelihood of not reporting sewer backups, such as areas that have lower incomes or that do not speak English. The areas with the highest risk of having sewer capacity deficiencies are identified on Figure 1-2 of the *Wastewater Systems Plan*. These high-risk areas would be evaluated in the future with GIS data, field investigations, and possibly with flow monitoring and modeling. After completion of the assessments, specific capital improvement projects for gravity sewers would be recommended.

Pump Stations and Force Mains: SPU would identify pump stations and force mains that are at a high risk of failure. SPU would identify and initially prioritize needed pump station and force main R&R projects. The proposed R&R program would decrease the risk of failure. Pump station projects would include preventative maintenance of existing facilities, such as replacing mechanical equipment, and would not require construction of new pump stations.

CSO Control: SPU would continue its program of achieving CSO reductions through best management practices (BMPs) and capital projects. BMPs would include enforcement of Seattle’s Stormwater, Grading, and Drainage Control Code, maintenance activities (e.g., cleaning), and minor modifications to the system to achieve the original design performance. Increased flow monitoring would characterize the number and quantity of CSO discharges and support evaluation of future projects.

A12. Location of the proposal. Give sufficient information for a person to understand the precise location of your proposed project, including a street address, if any, and section, township, and range, if known. If a proposal would occur over a range of area, provide the range or boundaries of the site(s). Provide a legal description, site plan, vicinity map, and topographic map, if reasonably available. While you should submit any plans required by the agency, you are not required to duplicate maps or detailed plans submitted with any permit applications related to this checklist.

The location of the *Wastewater Systems Plan* is the City of Seattle. SPU’s wastewater service area generally includes all the areas within the Seattle city limits. The SPU wastewater collection system service area is shown in Figure 2-1 of the *Wastewater Systems Plan*. Future wastewater programs and projects to implement the plan could occur at various locations within the City. The precise locations of future wastewater projects would be identified when individual wastewater programs and projects are implemented.

B. ENVIRONMENTAL ELEMENTS

B1. Earth

a. General description of the site:

☒ **Flat** ☐ **Rolling** ☒ **Hilly** ☒ **Steep Slopes** ☐ **Mountains**
☐ **Other:**

Seattle is located on a series of hills and intervening valleys in the Puget Sound lowlands. The Puget Sound and Lake Washington watersheds are separated by a ridge that generally runs north and south. The ridge is highest (over 400 feet above sea level) at the north end of the service area (Crown Hill). The ridge is lowest at the north end of Lake Union, where it is bisected by the Lake Washington Ship Canal. A number of other, smaller hills (200 to 300 feet in elevation) are scattered within the service area south of the Ship Canal. The topography was sculpted by a several periods of glaciation.

Any future wastewater projects to implement the *Wastewater Systems Plan* could occur in various locations within the City. Because specific wastewater projects are not proposed under the *Wastewater Systems Plan*, existing topography in the immediate vicinity of future wastewater project sites cannot be determined at this time.

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b. What is the steepest slope on the site (approximate percent slope)?
Slopes in Seattle range from 0 to 40 percent. Individual wastewater projects are not proposed under the *Wastewater Systems Plan*, and slopes at specific sites cannot be determined.

c. What general types of soils are found on the site (for example, clay sand, gravel, peat, muck)? If you know the classification of agricultural soils, specify them and note any prime farmland.
As the result of several periods of glaciation, a layer of hard, cemented glacial till underlies much of the service area. The permeable soils overlying the till are shallow, ranging from 2- to 4-feet deep, while the impermeable till layer may be quite thick. Compact clay (hardpan) often underlies the surface soils.

As a highly urbanized area, the native soils in Seattle have been extensively altered. The predominant soil types in the area are artificial fill, alluvial soils, and Alderwood series soils. Individual projects are not proposed under the *Wastewater Systems Plan*, and the soils at specific sites cannot be determined. Because Seattle has been previously developed for urban uses, prime farmland is no longer present within the City.

d. Are there surface indications or history of unstable soils in the immediate vicinity? If so, describe:
Unstable soils in Seattle primarily occur in areas of steep slopes and in areas of artificial fill or alluvial soils with a shallow water table that may lead to soil liquefaction during earthquakes. Areas where these conditions may exist have

been mapped by the City as critical areas. The official Land Use Map of the City of Seattle contains overlays identifying the general boundaries of all known critical areas within the City.

Because individual projects are not proposed under the *Wastewater Systems Plan*, unstable soils at specific sites cannot be determined at this time. The potential for unstable soils would be identified when individual wastewater programs and projects are implemented. All future projects would comply with the applicable provisions of the Seattle critical areas ordinance.

e. Describe the purpose, type, and approximate quantities of any filling or grading proposed. Indicate source of fill.

Individual projects are not proposed under the *Wastewater Systems Plan*, and the potential fill or grading at specific sites cannot be determined at this time. Grading and/or filling could occur in association with future wastewater projects and programs. In general, the amounts of grading and filling that would be required for individual projects would be relatively modest. The potential for fill and/or grading would be identified during final design, permitting, and construction of individual projects. All future projects would comply with the applicable grading provisions of the Seattle Stormwater, Grading and Drainage Control Code.

f. Could erosion occur as a result of clearing, construction, or use? If so, generally describe:

Future projects to implement the *Wastewater Systems Plan* could occur in various locations within Seattle. Although no specific projects are proposed, many future projects to implement the *Wastewater Systems Plan* would involve clearing and grading activities. Clearing and grading during construction could result in exposed soils and erosion, if uncontrolled. Erosion would be controlled with mitigation measures, which would be determined when individual projects are reviewed and permitted.

Construction activities would include best management practices (BMPs) to reduce erosion. All future wastewater projects would comply with the applicable erosion-control provisions of the Seattle Stormwater, Grading and Drainage Control Code.

g. About what percent of the site will be covered with impervious surfaces after project construction (for example, asphalt or buildings)?

Individual projects are not proposed under the *Wastewater Systems Plan*, and the amount of existing and future impervious surfaces cannot be determined at this time. Future projects could occur at various locations within the City of Seattle, which is a highly urbanized area with a large amount of existing impervious surfaces. Many of the pipeline programs and projects would take place within roadway rights-of-way, which already are primarily impervious surfaces. Renewal/replacement and maintenance programs for pipelines and pump stations would modify existing facilities and would not require substantial amounts of additional impervious surfaces. The programs and projects to implement the plan are not anticipated to result in a substantial increase in impervious surfaces city-wide. Any increase in impervious surface would be minor and would be unavoidable. The long-term, net impacts of the *Wastewater Systems Plan* would be no substantial increase in impervious surfaces.

h. Proposed measures to reduce or control erosion, or other impacts to the earth, if any.

Any future projects resulting from the *Wastewater Systems Plan* would be subject to the requirements of Seattle's Stormwater, Grading and Drainage Control Code (SMC 22.800-22.808), Side Sewer Code (SMC 21.16), and applicable Director's Rules. The City's Stormwater Management Plan includes guidelines and BMPs designed to manage stormwater and control runoff impacts during and after construction, thereby controlling and reducing erosion of soils. Future projects in geological hazard areas would undergo review under the Seattle critical areas ordinance, which could include site-specific mitigation measures.

B2. Air

a. What types of emissions to the air would result from the proposal (i.e., dust, automobile, odors, industrial wood smoke) during construction <u>and</u> when the project is completed? If any, generally describe and give approximate <u>quantities</u> if known.

No specific projects are proposed as part of the *Wastewater Systems Plan*. The programs and future wastewater projects anticipated under the plan would not be long-term sources of air pollutants. Wastewater pipelines and pump stations are not major long-term sources of air pollutants.

Wastewater facilities such as pipelines and pump stations occasionally can be sources of odors, particularly at locations near sensitive property. The proposed plan would not introduce any major new sources of odors, and the long-term, net impact would be no substantial increase in odors from wastewater facilities. Odors also occasionally occur from existing sewage backups and overflows. The proposed plan would reduce the number of future sewage backups and overflows and associated odors. Better maintenance of sewer pipelines also would reduce odors. The CSO reduction program would reduce odors generated during and after CSO events, but odors could be generated around new CSO storage facilities and pump stations. Implementation of the *Wastewater Systems Plan* would reduce long-term emissions of odors throughout the City, although the amount of reduction would be relatively small compared to the entire wastewater system.

Construction of individual wastewater projects to implement the plan would temporarily generate particulate matter and small amounts of engine exhaust. Potential construction impacts would be most noticeable at locations near construction activities, and would be considered short-term impacts. To reduce construction emissions, projects would include reasonable construction mitigation measures and would comply with the Puget Sound Clean Air Agency (PSCAA) regulations to minimize fugitive particulate matter. Because construction emissions would be temporary, comply with the PSCAA regulations, and include reasonable precautions as mitigation, air quality impacts during construction of the future projects would not be significant.

b. Are there any off-site sources of emissions or odor that may affect your proposal? If so, generally describe.

Wastewater facilities contemplated under the *Wastewater Systems Plan* would not be affected by off-site emissions or odors. There are no known off-site sources of emissions or odor that would affect this proposal.

c. Proposed measures to reduce or control emissions or other impacts to air, if any:

The design of future wastewater and CSO projects to implement the plan would include practical odor controls where necessary, and facilities would be properly maintained and operated. Construction of future wastewater projects would include reasonable mitigation measures to reduce construction emissions, such as such as spraying with water or covering exposed soil. Construction activities would comply with the PSCAA's requirements for reasonable precautions to minimize fugitive dust. Construction equipment also would include emission-control devices on gasoline and diesel engines to reduce carbon monoxide (CO) and particulate emissions.

B3. Water

a. Surface:

(1) Is there any surface water body on or in the immediate vicinity of the site (including year-round and seasonal streams, saltwater, lakes, ponds, wetlands)? If so, describe type and provide names. If appropriate, state what stream or river or water body it flows into.

The majority of Seattle is located within the Lake Washington/Cedar/Sammamish Watershed (Water Resource Inventory Area 8). The Duwamish Waterway and Elliott Bay are part of the Green/Duwamish and Central Puget Sound Watershed (Water Resource Inventory Area 9). Seattle is characterized by a wide variety of surface water features, including marine areas, rivers, lakes, and creeks.

The SPU service area includes four distinct, natural drainages. A large part of the service area generally drains eastward, toward Lake Washington, while another part drains westward, emptying directly into Puget Sound. A third part of the service area drains into the Duwamish River valley. A fourth basin drains to Lake Union and the Ship Canal, draining both northward from Queen Anne Hill, northern Capital Hill, and northern downtown Seattle; and southward from Ballard, Wallingford, and the University District neighborhoods.

The *Wastewater Systems Plan* is a planning document that does not identify individual projects, therefore affected surface water bodies cannot be determined at this time. Surface water bodies potentially affected by future projects would be identified when individual wastewater programs and projects are implemented.

(2) Will the project require any work over, in, or adjacent to (within 200 feet) the described waters? If so, please describe and attach available plans.

Individual projects are not proposed under the *Wastewater Systems Plan*, and the potential work affecting surface waters cannot be determined at this time. Construction activities could occur over, in, or adjacent to surface waters. The potential for work affecting surface waters would be identified during final design, permitting, and construction of individual projects. All future projects would comply with the applicable provisions of the Seattle Shoreline Master Program and other local, state, and federal regulations to protect surface waters.

(3) Estimate the <u>amount</u> of fill and dredge material that would be placed in or removed from surface water or wetlands and indicate the <u>area</u> of the site that would be affected. Indicate the <u>source</u> of fill material.

The nonproject *Wastewater Systems Plan* itself would not result in any fill or dredge activities. Individual projects are not proposed under the *Wastewater Systems Plan*, and the potential for fill and dredge materials in surface waters or wetlands cannot be determined at this time. Fill and/or dredge activity could occur in association with future wastewater projects and programs. The potential for fill and/or dredge material would be identified during final environmental review and permitting of individual projects. All future projects would comply with the applicable local, state, and federal regulations concerning fill and dredge materials.

(4) Will the proposal require surface water withdrawals or diversions? If so, give general description, purpose, and approximate quantities if known.

The nonproject *Wastewater Systems Plan* itself would not result in any surface water withdrawals or diversions. Because individual projects are not proposed, the potential for surface water withdrawals or diversions cannot be determined at this time. In general, the renewal/replacement, capacity, and maintenance projects likely to occur under the *Wastewater Systems Plan* would not require additional surface water withdrawals or diversions. Temporary diversions could occur during construction activities, which would comply with applicable provisions regulating surface water withdrawals and/or diversions.

(5) Does the proposal lie within a 100-year floodplain? If so, note location on the site plan.

Major streams and the Duwamish River in Seattle have associated 100-year floodplains. Individual projects are not proposed under the *Wastewater Systems Plan*, and the potential for specific projects within the 100-year floodplain cannot be determined at this time. Some of the future projects could occur in or near the City's floodplains. In general, the renewal/replacement, capacity, and maintenance projects likely to occur under the *Wastewater Systems Plan* would not require extensive new construction within the 100-year floodplain. The potential for projects within the 100-year floodplain would be identified when individual projects are proposed and reviewed under SEPA. All future projects would comply with any floodplain regulations, where applicable.

(6) Does the proposal involve any discharges of waste materials to surface waters? If so, describe the type of waste and anticipated volume of discharge.

The programs and future projects under the *Wastewater Systems Plan* would not create any new long-term discharges or outfalls into surface waters. The maintenance, renewal/replacement, and capacity improvement programs under the proposed plan would not increase discharges of waste materials to surface waters in the long-term, although short-term discharges could occur during construction.

The proposed plan would reduce the number of future sewage backups and overflows throughout Seattle. The sewer maintenance and renewal/replacement programs would reduce discharges from leaks, breaks, clogging, and anticipated failures of the City's aging gravity sewer pipelines. Implementation of the *Wastewater Systems Plan* therefore would reduce long-term discharges of untreated wastewater, although the amount of reduction would be relatively small.

The CSO reduction program of the *Wastewater Systems Plan* would result in improved water quality over existing conditions. The CSO program would reduce the contamination of offshore sediments and the contaminated waters entering receiving water bodies. Implementation of the *Wastewater Systems Plan* would reduce pollutant loading to receiving waters, which would directly benefit water quality for the Puget Sound, Lake Washington, the Duwamish River, Lake Union, and the Ship Canal. The CSO reduction program also would indirectly benefit aquatic resources and habitat, public health, and use of beaches and water-based recreation. The City's CSO reduction program would help SPU achieve the state regulations that limit CSO discharges to an average of not more than one untreated discharge per CSO outfall per year by 2020. The water quality and water resources impacts and benefits of the CSO reduction program are discussed in detail in the Draft and Final Environmental Impact Statements for the *2001 Combined Sewer Overflow Reduction Plan Amendment*, which are incorporated by reference into this SEPA Environmental Checklist.

Taken together, the various programs and strategies in the *Wastewater Systems Plan* would reduce the overall discharges of waste materials into surface waters in Seattle. The long-term effect on water quality and water resources would be a positive impact.

Individual projects are not proposed under the *Wastewater Systems Plan*, and the site-specific types and volumes of discharges to surface waters cannot be determined at this time. The potential discharges, if present, would be identified during environmental review and permitting of individual projects. All future wastewater projects would comply with the applicable local, state, and federal regulations concerning discharges to surface waters.

Site preparation and construction activities during implementation of individual projects under the *Wastewater Systems Plan* could intermittently generate surface water discharges, which would be considered temporary or short-term impacts. Construction activities would include BMPs and other mitigation measures to prevent discharges into surface waters, and would comply with applicable codes and regulations. Because construction discharges would be temporary, comply with the City, state, and federal regulations, and include reasonable mitigation, construction discharges into surface waters would not be significant.

b. Ground:

(1) Will ground water be withdrawn, or will water be discharged to ground water? If so, give general description, purpose, and approximate quantities if known.

The programs and future projects under the *Wastewater Systems Plan* would not create any new long-term groundwater discharges or withdrawals. The types of future wastewater projects likely to arise under the plan would not result in any substantial adverse long-term impacts on groundwater, although short-term impacts could occur during construction. The sewer maintenance and renewal/replacement programs would reduce the potential discharges to groundwater from leaks, breaks, clogging, and anticipated failures of the City's aging sewer pipelines.

Individual projects are not proposed under the *Wastewater Systems Plan*, and the site-specific quantities of groundwater withdrawals or discharges cannot be determined at this time. The site-specific impacts on groundwater, if present, would be identified during environmental review and permitting of individual projects. Any potential groundwater discharges from future projects would be regulated under the Seattle drainage code (SMC 22.802).

Construction of future projects to implement the plan could affect groundwater, although impacts would be relatively short term and minor. Construction could require below-ground work and may result in the need for temporary dewatering to maintain dry construction conditions.

(2) Describe waste material that will be discharged into the ground from septic tanks or other sources, if any (for example: domestic sewage; industrial, agricultural, etc.). Describe the general size of such systems, the number of houses to be served (if applicable), or the number of animals or humans the system(s) are expected to serve.

There are no known sources of waste material that would be discharged into groundwater associated with the *Wastewater Systems Plan*. The types of projects likely to occur under the *Wastewater Systems Plan* would not discharge waste material into groundwater.

c. Water Runoff (including storm water):

(1) Describe the source of runoff (including storm water) and method of collection and disposal, if any (include <u>quantities</u>, if known). Where will this water flow? Will this water flow into other waters? If so, describe.

Individual projects are not proposed under the *Wastewater Systems Plan*, and the site-specific quantities of runoff cannot be determined at this time. The potential for runoff and identification of receiving waters, if present, would be determined during environmental review and permitting of individual projects. Construction activities could temporarily increase runoff, which would be controlled with site-specific BMPs and other mitigation measures. The design, construction, and operation of all future projects would comply with the applicable stormwater runoff provisions of the Seattle Stormwater, Grading and Drainage Control Code.

Renewal/replacement and maintenance programs for pipelines and pump stations would modify existing facilities and would not require substantial amounts of additional impervious surfaces. The programs and projects to implement the plan are not anticipated to result in a substantial increase in impervious surfaces city-wide. Any increase in impervious surface would be minor and would be unavoidable. The long-term, net impacts of the *Wastewater Systems Plan* would be no substantial increase in stormwater runoff.

(2) Could waste materials enter ground or surface waters? If so, generally describe.

The typical residential-area waste materials that enter drainage systems or the ground, such as soap from car washing, motor oil leaks, exhaust residue, etc., would not be increased by this proposed plan. The types of projects likely to occur under the *Wastewater Systems Plan* would not increase the long-term discharge of waste materials into ground or surface waters.

d. Proposed measures to reduce or control surface, ground, and runoff water impacts, if any:

Construction activities would include mitigation measures to reduce surface water runoff and erosion, including best management practices (BMPs). Site-specific mitigation measures would be identified during the environmental review and permitting of individual projects.

All future wastewater and CSO projects to implement the plan would be designed, constructed, and operated to meet applicable local, state, and federal regulatory requirements. All projects would obtain the necessary permits concerning surface water, groundwater, and stormwater runoff. Future projects would comply with the applicable provisions of the Seattle Stormwater, Grading and Drainage Control Code.

B4. Plants

a. Check types of vegetation found on the site:

☒ Deciduous trees (check types): ☒ alder ☒ maple ☒ aspen ☒ other: various ornamentals
☒ Evergreen trees (check types): ☒ fir ☒ cedar ☒ pine ☒ other: various ornamentals
☒ Shrubs
☒ Grass
☐ Pasture
☐ Crop or grain
☒ Wet soil plants (check types): ☒ cattail ☒ buttercup ☒ bullrush ☒ skunk cabbage ☒ Other: various native and exotic rushes, sedges, grasses, and non-herbaceous plants
☒ Water plants (check types): ☒ water lily ☒ eelgrass ☒ milfoil ☒ Other:
☒ Other types of vegetation: various other vascular and non-vascular plants.

The *Wastewater Systems Plan* is a planning document that does not identify individual projects, therefore the types of vegetation at individual sites cannot be determined at this time. Vegetation potentially affected by future projects would be identified when individual wastewater projects are implemented under the plan.

The City of Seattle is a developed urban area, with few areas of native vegetation remaining. Urban development has altered much of the vegetation. In most developed areas, the existing vegetation includes coniferous and deciduous trees and landscaped areas. With the changes in land use, several non-native and invasive species have established themselves. Several areas of native vegetation, however, remain in the City's parklands and open spaces.

b. What kind and amount of vegetation will be removed or altered?

The *Wastewater Systems Plan* does not propose specific projects, and the site-specific impacts on vegetation cannot be determined at this time. Because the City of Seattle is a developed urban area with few areas of substantial vegetation, the amounts of vegetation to be removed or altered likely would be minor. Many of the future sites have been previously disturbed, and the little vegetation that remains is areas of grass or landscaping. Future maintenance, renew/replacement, and capacity improvement projects would affect existing wastewater facilities and would not require extensive alteration of existing vegetation. Some CSO storage projects could be located in parklands, however, which could affect existing vegetation. Vegetation on or adjacent to project sites, where present, could be disturbed by construction activities. If areas of vegetation would be removed or altered, vegetation would be restored following construction.

c. List threatened or endangered species known to be on or near the site.

The plan would result in programs and projects throughout the City of Seattle. White-top aster (Aster curtus) is a federal species of concern known to occur in King County, with suitable but limited habitat occurring in Seattle (grasslands and savannah). Because habitat for the white-top aster is limited within city limits, implementation of the *Wastewater Systems Plan* is unlikely to affect this species.

d. Proposed landscaping, use of native plants, or other measures to preserve or enhance vegetation on the site, if any:

If areas of vegetation would be removed or altered, vegetation would be restored following construction, according to City of Seattle standard construction practices. Areas would be restored, where possible, with plantings of native species and other appropriate vegetation that would benefit fish and wildlife in the area. Any CSO projects in parklands would be located and designed to minimize impacts on vegetation.

B5. Animals

a. Checkmark any birds and animals that have been observed on or near the site or are known to be on or near the site:

Birds: ☒ hawk ☒ heron ☒ eagle ☒ songbirds ☒ other: osprey, bald eagle, peregrine falcon, purple martin, owls (various species), pileated woodpecker, belted kingfisher, waterfowl species, Canada goose.
Mammals: ☒ deer ☐ bear ☐ elk ☒ beaver ☒ other: California sea

lion, river otter, muskrat, raccoon	
Fish:	☒ bass ☒ salmon ☒ trout ☒ herring ☒ shellfish ☒ other: various freshwater and marine species.

The *Wastewater Systems Plan* is a planning document that does not identify individual projects, therefore the types of birds and animals on or near individual sites cannot be determined at this time. Fish and wildlife potentially affected by future projects would be identified when individual wastewater projects are reviewed under SEPA and permitted.

The City of Seattle is a developed urban area, with few areas of native vegetation and associated habitat remaining. Wildlife found in most areas of Seattle consists of wildlife that can tolerate or benefit from close association with humans and habitat fragmentation. Several areas of wildlife habitat, however, remain in the City's parklands and open spaces. Seattle is characterized by surface water features, including marine areas, rivers, lakes, and creeks. These water bodies provide habitat for a variety of fish, birds, shellfish, aquatic vegetation, and marine mammals.

b. List any threatened or endangered species known to be on or near the site:

The *Wastewater Systems Plan* would result in programs and projects throughout Seattle. The federal and state listed fish and wildlife species that may be present either within the City or in the vicinity include:

- Bald eagle
- Orca
- Marbled murrelet
- Chinook salmon
- Bull trout
- Humpback whale
- Stellar sea lion
- Leatherback sea turtle

Coho salmon is a federal candidate species that occurs throughout Puget Sound, in the Duwamish Waterway, the Lake Union/Ship Canal system, and in Thornton and Piper's Creeks.

c. Is the site part of a migration route? If so, explain.

Seattle is an upland corridor for bald eagles traveling to and from foraging areas in Puget Sound or Lake Washington. Marbled murrelets winter on marine waters and nest in late successional/old growth forests during late spring and summer. Murrelets make daily trips to the ocean and nearshore areas to gather food. Seattle also is within the migration routes of many migratory bird species.

Bull trout, steelhead, and Chinook, chum, pink, and coho salmon use the Puget Sound nearshore as a migration corridor. Anadromous trout and salmon migrate through Seattle creeks, the Duwamish River, and the Ship Canal/Lake Union/Lake Washington system on their way to the ocean and upon their return to freshwaters for spawning.

d. Proposed measures to preserve or enhance wildlife, if any:

The *Wastewater Systems Plan* does not propose specific projects, and the site-specific impacts and mitigation measures for fish and wildlife cannot be determined at this time. Future maintenance, renewal/replacement, and capacity improvement projects would improve existing facilities and would not require extensive alteration of existing habitat. Because the City of Seattle is a developed urban area with few areas of wildlife habitat, any long-term impacts on wildlife would be relatively low. Some CSO reduction projects could be located in parklands, which could affect wildlife habitat.

Fish, marine mammals, shellfish, birds, and aquatic vegetation are affected by CSO discharges. The CSO program of the *Wastewater Systems Plan* would result in improved water quality over existing conditions. Improved water quality would benefit aquatic resources and habitat in the Puget Sound, Lake Washington, the Duwamish River, Lake Union/Ship Canal, and other Seattle water bodies. The City's CSO reduction program would help SPU achieve the state regulations that limit CSO discharges to an average of not more than one untreated discharge per CSO outfall per year by 2020. The fish and wildlife impacts and benefits of the CSO reduction program, including threatened and endangered species, are discussed in detail in the Draft and Final Environmental Impact Statements for the *2001 Combined Sewer Overflow Reduction Plan Amendment*, which are incorporated by reference into this SEPA Environmental Checklist. The long-term impacts on fish and wildlife of CSO reductions would be beneficial.

Construction of future wastewater projects would have the potential for short-term impacts on aquatic resources, primarily from temporary erosion and sedimentation. To mitigate short-term impacts on fish and wildlife, standard erosion control measures and BMPs would be implemented to avoid serious erosion and sedimentation problems. Construction activities also could disturb vegetation and associated wildlife habitat, where present. Vegetation would be restored, where possible, with plantings of native species and other appropriate vegetation that would benefit fish and wildlife in the area.

All future wastewater projects under the plan would be designed, constructed, and operated to meet applicable local, state, and federal regulatory requirements. Future projects also would be designed to avoid or minimize potential impacts on biological resources. Prior to construction, each project would obtain applicable permits and approvals related to biological resources, such as the critical areas review, a shoreline substantial development permit, and a Hydraulic Project Approval (HPA). The permits could include conditions for mitigation of impacts on biological resources specific to each wastewater project.

B6 Energy and Natural Resources

a. What kinds of energy (electric, natural gas, oil, wood stove, solar) will be used to meet the completed project's energy needs? Describe whether it will be used for heating, manufacturing, etc.

The programs and future projects under the *Wastewater Systems Plan* together would not require any major increase in regional long-term energy use. The plan would not introduce any new wastewater facilities that would use substantial amounts of energy, but would modify existing pipelines and pump stations. New pump stations could be required for the CSO reduction program. Individual pump stations would run intermittently on electricity, with standby gasoline/diesel generators for emergency conditions. Replacement of mechanical equipment in pump stations would not likely increase existing electrical demand to the pump stations, and the new equipment would be more energy-efficient. The long-term, net impact would be no substantial increase in regional energy use at wastewater and CSO facilities implemented under this plan. Any potential increase in energy use would be unavoidable and would be minor compared to regional energy supplies. Electrical power would be supplied though the existing power lines, and the electrical infrastructure within the vicinity of the existing pump stations would be adequate to handle future loads. No new power sources would be required.

Construction of individual wastewater projects required to implement the plan would use energy for construction equipment and vehicles, which would temporarily use electricity and gasoline/diesel fuel. Energy use during construction would be short term and would be have a negligible impact on regional energy supplies.

b. Would your project affect the potential use of solar energy by adjacent properties? If so, generally describe.

The proposed plan would not involve building large, new structures or planting vegetation that would block access to the sun for adjacent properties.

c. What kinds of energy conservation features are included in the plans of this proposal? List other proposed measures to reduce or control energy impacts, if any:

Construction activities and operation of wastewater facilities would include measures to conserve energy, such as selection of energy-efficient equipment and implementation of energy-efficient operational practices. Construction contractors could use energy-efficient equipment and methods. Future SPU projects under the plan could incorporate conservation and efficiency measures into their design to meet applicable energy and building codes, and to be consistent with City's Sustainable Building Policy where applicable. The City of Seattle adopted a policy requiring all new construction and major renovations to be designed and built in a sustainable manner, and applicable projects would be evaluated based on the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) Rating System.

B7. Environmental Health

Note: Under SEPA, environmental health covers several types of potential impacts that could affect human health. Environmental Health under this section of a SEPA Environmental Checklist evaluates primarily public health, toxic/hazardous materials, and noise. Environmental health also could be affected by water quality and air quality, which are evaluated in other sections of this Checklist.

a. Are there any environmental health hazards, including exposure to toxic chemicals, risk of fire and explosion, spill, or hazardous waste, that could occur as a result of this proposal? If so, describe:

Potential long-term environmental health hazards associated with wastewater facilities addressed under the *Wastewater Systems Plan* would include public health and toxic/hazardous material. Toxic and hazardous materials could be released occasionally to the environment during sewage backups into residences and other structures and during overflows onto ground surfaces, although the toxic/hazardous component of the sewage would be relatively low in most places. The proposed plan would reduce the number of future sewage backups and overflows, and associated releases of toxic/hazardous material.

Implementation of the *Wastewater Systems Plan* would reduce long-term emissions of toxic chemicals and hazardous materials throughout the City.

Potential wastewater facilities addressed under the *Wastewater Systems Plan* could affect public health directly by human contact with wastewater during sewage backups and overflows, and indirectly by future growth of mold in residences after sewage backups. The *Wastewater Systems Plan* would reduce the number of future sewage backups and overflows throughout Seattle, which would be a long-term improvement in public health.

Failure or collapse of a pipeline could temporarily expose the public to untreated wastewater until the system is repaired. The sewer renewal and replacement (R&R) program would reduce anticipated failures of the City's aging sewer pipelines, which would reduce the potential for accidental releases affecting public health.

Public health is related to CSO discharges, by direct human contact with discharges during water activities and by ingestion of shellfish exposed to discharges. The CSO program of the *Wastewater Systems Plan* would result in improved water quality over existing conditions, which would benefit public health. The City’s CSO reduction program would help SPU achieve the state regulations that limit CSO discharges to an average of not more than one untreated discharge per CSO outfall per year by 2020. Reduction in the frequency and volume of CSO discharges would lower the potential human exposure to harmful bacteria, viruses, metals, and petroleum products contained in the CSOs. CSO reductions would reduce human health risks in areas where overflows discharge near areas of heavy human use, such as parks, beaches, and other public access points. The environmental health impacts and benefits of the CSO reduction program are discussed in detail in the Draft and Final Environmental Impact Statements for the *2001 Combined Sewer Overflow Reduction Plan Amendment*, which are incorporated by reference into this SEPA Environmental Checklist.

Taken together, the various programs and strategies in the *Wastewater Systems Plan* would reduce the overall discharge of waste materials in Seattle. The long-term effect on environmental health would be a positive impact.

Construction of individual wastewater projects to implement the proposed plan could occasionally release environmental hazards during leaks and spills. Small amounts of materials likely to be present during construction could include gasoline and diesel fuels, hydraulic fluids, oils, lubricants, solvents, paints, and other chemical products. A spill of one of these chemicals could potentially occur during construction as a result of either equipment failure or worker error. Contaminated soils, sediments, or groundwater also could be exposed during excavation. If disturbed, contaminated substances could expose construction workers and potentially other individuals in the vicinity through blowing dust, stormwater runoff or vapors. Construction would be subject to applicable spill containment and cleanup procedures.

(1) Describe special emergency services that might be required.

Possible fire or medic services could be required during construction, as well as possibly during maintenance of wastewater facilities.

(2) Proposed measures to reduce or control environmental health hazards, if any:

Prior to construction of individual wastewater projects, a Construction Contingency Plan and a Health and Safety Plan would be submitted by the contractor before work commences. The construction workers would have had 40-hour OSHA Health and Safety Training for working in potentially contaminated areas.

A hazardous material and spill control plan would be developed to control spills on construction sites. In areas of suspected contamination, soil testing would be conducted prior to construction to determine the extent of contamination. Any contaminated soils would be excavated and disposed of in a manner consistent with the level of contamination, in accordance with federal, state and local regulatory requirements, by a qualified contractor(s) and/or City staff.

b. Noise

(1) What types of noise exist in the area which may affect your project (for example: traffic, equipment, operation, other)?

The proposed *Wastewater Systems Plan* covers the City of Seattle, and future wastewater projects would occur throughout the City. Existing noise levels include a variety of noise sources that are characteristic of an urban area. The existing noise sources would not affect future wastewater programs and projects under the proposed plan.

(2) What types and levels of noise would be created by or associated with the project on a short-term or a long-term basis (for example: traffic, construction, operation, other)? Indicate what hours noise would come from the site.

The programs and future projects under the *Wastewater Systems Plan* would not create any new major sources of noise. Individual pump stations would intermittently generate noise, while pipelines would be below ground and not be sources of noise. Most noise-emitting equipment would be inside buildings or underground. Replacement of mechanical equipment in existing pump stations would not likely increase noise levels. The CSO reduction program could result in new pump stations, which could increase noise levels in the immediate vicinity. The overall, long-term impact of the plan would be no substantial increases in existing noise levels. Future individual wastewater and CSO facilities would not be major sources of long-term noise, and the design and operation of SPU facilities would comply with the Seattle noise ordinance.

Site preparation and construction activities during implementation of individual projects under the plan would intermittently generate noise, which would be considered temporary or short-term impacts. Potential construction noise would be most noticeable at locations near construction activities, and during nighttime construction if proposed. Short-term noise from construction equipment would be limited to the allowable maximum levels of City of Seattle's Noise Control Ordinance (SMC Chapter 25.08). Because construction noise would be temporary, comply with the City noise ordinance, and include reasonable noise mitigation, construction noise impacts would not be significant.

Under the Seattle noise ordinance, noise from construction equipment may occur between the hours of 7 am and 9 pm weekdays, and 9 am to 9 pm weekends during construction.

After completion of the project, occasional noise from equipment used for on-going routine maintenance and repair would occur, but would be limited to 7 am to 9 pm weekdays and 9 am to 9 pm weekends.

(3) Proposed measures to reduce or control noise impacts, if any:
Construction of future projects arising under this plan would include reasonable mitigation measures, where required, to reduce potential site-specific construction noise impacts. Reasonable measures could include restrictions on nighttime construction activities, mufflers and enclosures for equipment, turning off idling equipment, and locating equipment farther away from receptors. Construction equipment would be muffled in accordance with the applicable laws. SMC Chapter 25.08, which prescribes limits to noise and construction activities, would be fully enforced while future projects would be under construction.

Potential noise controls for future pump stations would be evaluated during the design phase, particularly at locations where noise-sensitive properties are nearby. The aboveground facilities would be located and designed to operate within applicable noise levels within the Seattle noise ordinance.

B8. Land and Shoreline Use

a. What is the current use of the site and adjacent properties?
The *Wastewater Systems Plan* is a planning document that does not identify individual projects, therefore the current uses of future sites and adjacent properties cannot be determined at this time. Land and shoreline uses potentially affected by future projects would be identified when individual wastewater projects are reviewed under SEPA and permitted.

Seattle is a developed urban area. Existing uses include single-family and multifamily residences, commercial, industrial, recreation, and open spaces. Most properties have been developed at urban densities, and existing uses are often mixed. The downtown area includes many high-rise developments.

b. Has the site been used for agriculture? If so, describe.
The City of Seattle has not been used for agriculture in recent history.

c. Describe any structures on the site.
Seattle is developed with a wide range of structures, ranging from single-family residences to high-rise office towers to large industrial structures. Specific structures on sites of future projects cannot be identified at this time.

d. Will any structures be demolished? If so, what?
Individual projects under the *Wastewater Systems Plan* could require demolition of some structures, but none are identified at this time. Future maintenance, renew/replacement, and capacity improvement projects likely would not require any demolition. Future projects under the plan would be located and designed to avoid demolition of existing structures where possible.

e. What is the current zoning classification of the site?

The *Wastewater Systems Plan* covers all zones within the City of Seattle. Zoning in Seattle includes a range of residential, commercial, and industrial designations. Zoning designations are found in Seattle's Land Use Code, Title 23 of the Seattle Municipal Code.

The *Wastewater Systems Plan* is a planning document that does not identify individual projects, therefore the current zoning of future sites cannot be determined at this time. Zoning classifications of future sites would be identified when individual wastewater projects are reviewed under SEPA and permitted.

f. What is the current comprehensive plan designation of the site?

Because the *Wastewater Systems Plan* would encompass all of Seattle, future projects to implement the plan could include all of the designations in Seattle's *Comprehensive Plan*. The planning designations include residential, commercial, and industrial, as well as Urban Centers and Urban Villages. The current comprehensive plan designations of future sites would be identified when individual wastewater projects are reviewed under SEPA and permitted.

g. If applicable, what is the current shoreline master program designation of the site?

The *Wastewater Systems Plan* is a planning document that does not identify individual projects, therefore the shoreline designations of future sites cannot be determined at this time. The City of Seattle contains both freshwater and marine shorelines. Some future projects could be located in the shoreline zone, and be subject to the Seattle Shoreline Master Program (SMP). Shoreline resources regulated under the SMP include all marine waters, larger streams and lakes, associated wetlands and floodplains, and upland areas called shorelands that extend 200 feet landward from the edges of these waters. Shoreline uses and applicable portions of the Seattle SMP would be identified when individual wastewater projects are reviewed under SEPA and permitted. If a future project were sited within regulated shorelines, a shoreline substantial development permit, variance, or conditional use permit could be required.

h. Has any part of the site been classified as an "environmentally sensitive" area? If so, specify.

The *Wastewater Systems Plan* is a planning document that does not identify individual projects, therefore potential environmentally sensitive areas cannot be determined at this time. The City of Seattle contains several environmentally sensitive areas. Some future projects could affect environmentally sensitive areas, and be subject to the Seattle critical areas regulations. Critical areas in Seattle include geologic hazards, flood-prone areas, riparian corridors, wetlands, fish and wildlife habitat conservation areas, and abandoned landfills. Critical areas are mapped and regulated under the Seattle Environmentally Critical Areas Policies in SMC Chapter 25.09. The official Land Use Map of the City of Seattle contains overlays identifying the general boundaries of all known critical areas within the City. The presence of potential critical areas and site-specific impacts and mitigation would be evaluated when wastewater projects are reviewed under SEPA and permitted.

i. Approximately how many people would reside or work in the completed project?

The proposed plan would not include any residential or commercial development, and therefore people would not reside or work in the future projects.

j. Approximately how many people would the completed project displace?

It is not anticipated that the *Wastewater Systems Plan* would displace any residences. The maintenance, renewal/replacement, and capacity projects would modify existing facilities, and would not likely displace any people or properties. However, future projects arising under the plan would evaluate whether potential impacts to or acquisition of property rights might be desirable under certain circumstances and on a very restricted basis.

k. Proposed measures to avoid or reduce displacement impacts, if any:

Displacement impacts are not anticipated, and therefore displacement mitigation measures would not be required. Future projects to implement the plan would be designed to avoid or reduce potential displacements, where possible. CSO storage facilities would be located in vacant areas, where possible, to avoid direct displacement or disturbance to houses and businesses.

l. Proposed measures to ensure the proposal is compatible with existing and projected land uses and plans, if any:

Prior to construction of the future projects, SPU would apply for and obtain the applicable land use permits and approvals. Similarly, SPU would obtain any applicable shoreline substantial development permit, variance, or conditional use permit where applicable. Design, construction, and operation of the individual wastewater facilities would follow City of Seattle zoning and development standards for mitigating potential impacts on adjacent land uses. Future individual permits could include site-specific conditions or mitigation measures to meet the requirements of the applicable Seattle land use, zoning, and shoreline codes and policies.

The City has prepared and adopted Seattle's *Comprehensive Plan*, which was last updated in 2004. The *Comprehensive Plan* contains policies on utilities and identifies areas for future growth, which have been sources of direction for the *Wastewater Systems Plan*. The proposed *Wastewater Systems Plan* is consistent with the goals and the policies of the Utilities Element of the *Comprehensive Plan*. Any growth in the City encouraged by implementation of the *Wastewater Systems Plan* would generally occur in areas identified for future development in the *Comprehensive Plan*.

B9. Housing

a. Approximately how many units would be provided, if any? Indicate whether high, middle, or low-income housing.

The proposed plan would not provide any housing units.

b. Approximately how many units, if any, would be eliminated? Indicate whether high, middle, or low-income housing.

It is not anticipated that any housing units would be eliminated or displaced under the proposed plan. CSO storage facilities would be located in vacant land, where possible, to avoid direct displacement of houses. Development of individual projects would evaluate whether impacts to or acquisition of private property might be reasonable under certain circumstances and on a very restricted basis.

c. Describe proposed measures to reduce or control housing impacts, if any:

Implementation of the proposed plan would not result in any displacement impacts on housing, and therefore mitigation measures would not be required. Design, construction, and operation of the individual SPU facilities would comply with Seattle Land Use and Shoreline regulations, as well as Seattle Housing Office policies.

B10. Aesthetics

a. What is the tallest <u>height</u> of any proposed structure(s), not including antennas? What is the principal exterior <u>building material</u>(s) proposed?

The potential heights and exterior building materials of future projects cannot be identified at this time, because the proposed plan is a nonproject action. Future wastewater facilities proposed to implement the *Wastewater Systems Plan* would not result in substantial long-term changes to the appearances of most project sites. Visible structures would be the existing pump stations, while pipelines would be below ground. Some CSO reduction projects could include new structures, although the height, bulk and scale of above-ground CSO projects would be relatively small. Large CSO storage projects would be below ground. Major above-ground structures would not be proposed. Some existing pump stations would be renewed or replaced, which would not substantially change their existing height, bulk and scale, and exterior building materials. The net long-term impact would be no substantial change in the aesthetics of the wastewater facilities contemplated under the proposed plan. All future projects under the plan would be subject to the height restrictions of the Seattle Zoning Code.

During construction of potential future wastewater facilities, the project sites would be cleared and graded. Exposed earth, materials, and construction vehicles would be temporarily visible from adjacent properties and roadways. Because most projects would occur in developed urban areas, minimal vegetation would be removed during construction. Any construction impacts on aesthetics would be short term and would not be considered significant.

b. What views in the immediate vicinity would be altered or obstructed?

Below-ground installations would not affect views. Some above-ground wastewater facilities would be renewed or replaced, mostly within existing structures,, which would not alter or obstruct existing views. Some CSO reduction projects could include new above-ground structures, although their size would be relatively small. Any potential impacts on views would be evaluated when individual projects undergo SEPA and permitting reviews.

c. Proposed measures to reduce or control aesthetic impacts, if any:

Future new projects and modifications of the individual wastewater facilities, where applicable, would meet the City of Seattle Land Use Code and the Director's Rules. Additional landscaping could be required. Exterior building materials would be designed to be compatible with each project site.

B11. Light and Glare

a. What type of light or glare will the proposal produce? What time of day would it mainly occur?

Implementation of the proposed *Wastewater Systems Plan* would not introduce any new long-term sources of light or glare. Individual wastewater projects proposed in the future would be renewal or replacement of existing pipelines and pump stations, which would not be long-term sources of light or glare. The net long-term impact would be no substantial increase in the light or glare of the wastewater facilities contemplated under the proposed plan. Construction activities could be short-term sources of light and glare. Most construction activities would be limited by the Seattle noise ordinance to the hours of 7 am and 9 pm weekdays, and 9 am to 9 pm weekends.

b. Could light or glare from the finished project be a safety hazard or interfere with views?

Individual wastewater projects would not be long-term sources of light or glare. The proposed *Wastewater Systems Plan* would not increase safety hazards or interfere with views.

c. What existing off-site sources of light or glare may affect your proposal?

The proposed *Wastewater Systems Plan* covers the City of Seattle, and future projects would occur throughout the City. Existing sources of light and glare are characteristic of an urban area. Future projects under the plan would not be affected by other existing off-site sources of light or glare.

d. Proposed measures to reduce or control light and glare impacts, if any:

The proposed plan would not result in any light and glare impacts, and therefore mitigation measures would not be required.

B12. Recreation

a. What designated and informal recreational opportunities are in the immediate vicinity?

The proposed *Wastewater Systems Plan* covers the City of Seattle, and future wastewater projects would occur throughout the City. Seattle has a variety of recreational opportunities, including city parks, trails, gardens, playfields, swimming pools, community centers, golf courses, school playgrounds, fishing piers, and private health clubs. Puget Sound, Lake Washington, Lake Union, and other water bodies also offer water-related recreation such as swimming, boating, fishing, use of public beaches, and scuba diving. Because specific projects are not proposed under the *Wastewater Systems Plan*, recreational opportunities in the immediate vicinity of future wastewater projects cannot be determined. Recreational opportunities and their potential impacts would be identified when individual wastewater projects are implemented.

b. Would the proposed project displace any existing recreational uses? If so, describe.

The future wastewater programs and projects contemplated under the *Wastewater Systems Plan* are not anticipated to permanently displace any existing recreational resources. Operation of recreational resources could be indirectly affected by local changes in traffic, noise, aesthetics, and water quality, although the long-term indirect impacts would be low. During construction, localized recreational uses could be temporarily affected at project sites near recreational resources. Some CSO reduction projects could be located in Seattle parklands, although the largest CSO structures would be underground. Any potential impacts on parklands would be evaluated when individual projects undergo SEPA and permitting reviews.

The CSO program of the *Wastewater Systems Plan* would result in improved water quality over existing conditions, which would benefit recreation. Reduction in the frequency and volume of CSO discharges would reduce human health risks in areas where overflows discharge near recreation areas, such as parks, beaches, and other public access points. The water quality and associated recreation impacts and benefits of the CSO reduction program are discussed in detail in the Draft and Final Environmental Impact Statements for the *2001 Combined Sewer Overflow Reduction Plan Amendment*, which are incorporated by reference into this SEPA Environmental Checklist.

c. Proposed measures to reduce or control impacts on recreation, including recreation opportunities to be provided by the project or applicant, if any:

Impacts on recreational opportunities would be avoided wherever possible, and would be addressed when individual projects are proposed. Potential CSO projects within parklands would be designed to minimize impacts on recreation, and would be coordinated with Seattle Parks and Recreation. Short-term construction impacts would be minimized to the maximum extent possible.

B13. Historic and Cultural Preservation

a. Are there any places or objects listed on, or proposed for, national, state, or local preservation registers known to be on or next to the site? If so, generally describe.

The proposed *Wastewater Systems Plan* covers the City of Seattle, and future projects would occur throughout the City. Seattle includes a number of landmarks, properties, or districts that are listed on, or proposed for, national, state, and local preservation registers. In addition, Seattle is an area with potential for Native American artifacts. Because specific projects are not proposed under the *Wastewater Systems Plan*, historic and cultural resources in the immediate vicinity of future wastewater projects cannot be determined at this time. The potential to encounter historic, cultural, or archaeological resources would be assessed when individual wastewater projects are implemented.

b. Generally describe any landmarks or evidence of historic, archaeological, scientific, or cultural importance known to be on or next to the site.

See B13.a above.

c. Proposed measures to reduce or control impacts, if any:

Implementation of individual wastewater projects arising under the proposal could have the potential to affect historic and cultural resources, if present. Prior to implementation of individual projects, the City would assess the potential for disturbance of cultural, archaeological, or historic sites.

If any cultural/archaeological resources were discovered during construction activities, the City of Seattle would immediately consult with the Washington State Office of Archaeology and Historic Preservation (OAHP), affected tribes, and other appropriate officials regarding mitigation measures. Work in that immediate area would be suspended, and decisions regarding appropriate mitigation and further action would be made at that time.

B14. Transportation

a. Identify public streets and highways serving the site, and describe proposed access to the existing street system. Show on site plans, if any.

Any future wastewater projects to implement the *Wastewater Systems Plan* could occur throughout the City. Seattle has a variety of transportation facilities, including roadways, bicycle paths, railroads, airports, ferries, and public transit. Because specific wastewater projects are not proposed under the *Wastewater Systems Plan*, public streets and highways in the immediate vicinity of future wastewater projects cannot be determined at this time. Public roadways and accesses potentially affected would be identified when individual wastewater projects are implemented.

b. Is site currently served by public transit? If not, what is the approximate distance to the nearest transit stop?

See B14a above.

c. How many parking spaces would the completed project have? How many would the project eliminate?

Future wastewater projects of the type required to implement the *Wastewater Systems Plan* would require few parking spaces. Some CSO storage projects could be located under largely vacant areas such as parking areas, and any potential site-specific impacts on parking would be evaluated when individual projects are proposed. Future wastewater projects are not anticipated to substantially alter the number of existing parking spaces.

d. Will the proposal require any new roads or streets, or improvements to existing roads or streets, not including driveways? If so, generally describe (indicate whether public or private).

Future wastewater projects of the type required to implement the *Wastewater Systems Plan* are not expected to require new roads or accesses, or to generate substantial traffic. Renewal or modification to existing wastewater facilities would continue to use the existing roadways and access points that serve the project sites.

Wastewater projects could affect roads or streets by occasionally overflowing sewage onto ground surfaces and by collapsing of pipelines within public rights-of-way. The proposed *Wastewater Systems Plan* would reduce the number of future sewage backups and overflows, and the renewal and replacement (R&R) program would reduce anticipated failures of the City's aging pipelines under public streets. By preventing pipeline failures and unplanned repairs in streets, implementation of the *Wastewater Systems Plan* would be a long-term benefit to the City's roads and streets.

Construction of individual projects could occur near or within City roadways, which could temporarily disrupt traffic. Access could be restricted to adjacent residences and businesses. Road restrictions also could temporarily interfere with transit, ferry, and emergency service vehicles. To reduce construction impacts, individual projects would include mitigation measures to minimize traffic disruptions and maintain accesses. Because construction impacts would be temporary and include mitigation, transportation impacts during construction would not be significant.

e. Will the project use (or occur in the immediate vicinity of) water, rail, or air transportation? If so, generally describe.

Because specific wastewater projects are not proposed under the *Wastewater Systems Plan*, other transportation facilities in the immediate vicinity of future projects cannot be determined at this time. Any water, rail, or air transportation facilities potentially affected would be identified when individual projects are implemented. Future wastewater projects of the type required to implement the *Wastewater Systems Plan* typically would not result in long-term use of water, rail, or air transportation.

The proposed *Wastewater Systems Plan* would reduce the number of future sewage backups and overflows, and the renewal and replacement (R&R) program would reduce anticipated failures of the City's pipelines. By reducing overflows, pipeline failures, and unplanned repairs potentially affecting nearby transportation facilities, implementation of the *Wastewater Systems Plan* would be a long-term benefit to the City's transportation network. Construction of individual projects could occur in the immediate vicinity of water, rail, and air transportation, which could result in temporary disruptions. To reduce construction impacts, individual projects would include mitigation measures to minimize disruptions and would be coordinated with affected transportation providers.

f. How many vehicular trips per day would be generated by the completed project? If known, indicate when peak volumes would occur.

Operation of future wastewater projects under the proposed plan would generate few vehicular trips. These facilities would not be permanently staffed on site, and vehicle trips would be limited to maintenance activity. The number of long-term vehicular trips and peak volumes are not expected to increase as a result of this proposal. Construction activities would temporarily generate vehicle trips for workers and hauling materials. The number of construction vehicles would be relatively small compared to traffic on local roadways, and the effects of construction traffic would not be significant.

g. Proposed measures to reduce or control transportation impacts, if any:

Construction of individual projects would include mitigation measures to reduce short-term impacts on affected roadways and adjacent properties. Accesses to affected residences and businesses from local roadways would be maintained during the construction periods. Vehicular travel along local roadways also would be maintained to allow passage of emergency service vehicles. The Seattle Department of Transportation (SDOT) would be notified of any project that would involve construction with the street right-of-way, and a street use permit would be obtained. Street restoration would meet the requirements in SDOT's *Street Improvement Manual*.

Construction mitigation measures would be established prior to the development of the individual wastewater projects, and a Traffic Control Plan typically would be prepared for approval by the City. Traffic plans would ensure continued circulation and access during construction. Construction activities would be coordinated with affected landowners, local businesses, emergency service providers, transit services, and the City of Seattle. For example, construction contracts could stipulate that contractors use flaggers and traffic controls to maintain vehicle access if lanes were temporarily closed during construction.

B15. Public Services

a. Would the project result in an increased need for public services (for example: fire protection, police protection, health care, schools, other)? If so, generally describe.

Implementation of the *Wastewater Systems Plan* would not result in a long-term increase in the need for most public services. Occasional spills during construction and operation of wastewater facilities could require responses from emergency service providers. Improved maintenance, reduction of future sewage backups and overflows, and the renewal and replacement (R&R) program could reduce the frequency of spills and the overall need for public services. Construction activities could affect local circulation and access on city streets, which could affect emergency service vehicles.

b. Proposed measures to reduce or control direct impacts on public services, if any.

Because public services would not be directly affected, mitigation measures would not be required. Any potential spills during construction and operation of future projects to implement the plan would be contained and cleaned up under applicable state and local provisions. During construction, access and circulation would be maintained for emergency service vehicles.

B16. Utilities

a. Check utilities currently available at the site, if any: ☐ **None**

☒ **electricity** ☒ **natural gas** ☒ **water** ☒ **refuse service**
☒ **telephone** ☒ **sanitary sewer** ☒ **septic system**
☒ **other: c**able, drainage

Any future wastewater projects to implement the *Wastewater Systems Plan* would occur throughout the City. Seattle has a variety of utilities, including those checked above. Because specific wastewater projects are not proposed under the *Wastewater Systems Plan*, existing utilities in the immediate vicinity of future wastewater projects cannot be determined at this time. Any utilities potentially affected would be identified when individual wastewater projects are implemented.

b. Describe the utilities that are proposed for the project, the utility providing the service, and the general construction activities on the site or in the immediate vicinity which might be needed. ☐ **None**

Implementation of the plan would directly affect the utilities services provided by SPU. The other utility most likely to be affected by long-term operation of future wastewater projects is electricity. Wastewater facilities of those contemplated under the proposed plan typically use electricity. Pump stations would consume the most energy, although energy use would not increase in the long term and would be minor compared to regional demand (see Section B6 above). Electrical power would be supplied though the existing power lines, and the electrical infrastructure within the vicinity of the pump stations would be adequate to handle future loads. No new utilities would be required. Long-term demands on water, refuse, telephone, and other utilities would be negligible.

Repairing or replacing sewer lines could temporarily disrupt utilities, such as water, sewer, drainage, power, and communication utilities. Potential impacts during construction would be short term and site specific, to be determined when individual projects are proposed. Construction of individual wastewater projects required to implement the plan could temporarily disrupt utility service in the immediate area. To reduce construction impacts, individual projects would include site-specific mitigation measures to minimize disruptions to utilities. SPU would work cooperatively with the various utilities and service providers to ensure continued service during construction.

C. SIGNATURE

The above answers are true and complete to the best of my knowledge. I understand that the lead agency is relying on them to make its decision.

Signature: Martha Burke Date: 12-08-05

Martha Burke, Project Manager
Seattle Public Utilities

D. SUPPLEMENTAL SHEET FOR NONPROJECT ACTIONS

Note: The SPU Wastewater Systems Plan is a nonproject planning document under SEPA. Implementation of the Wastewater Systems Plan would involve the evaluation of programs, strategies, and capital improvement projects designed to address wastewater and CSO needs throughout Seattle. No specific projects, however, would be implemented directly as a result of adoption of the Wastewater Systems Plan. The following sections of this SEPA Environmental Checklist evaluate the programmatic components of the Wastewater Systems Plan, and do not discuss potential site-specific impacts of future projects (e.g. construction activities) that may result subsequent to adoption of the Wastewater Systems Plan. Future projects to implement the plan would undergo applicable environmental review and permitting at the time the individual projects are proposed.

1. How would the proposal be likely to increase discharge to water; emissions to air; production, storage, or release of toxic or hazardous substances; or production of noise?

The programs and future projects under the Wastewater Systems Plan would not substantially increase the long-term discharges of pollutants in the Seattle area. The types of future projects likely to implement the plan are not anticipated to be major new sources of pollutants. SPU wastewater and CSO projects would tend to reduce wastewater and stormwater discharges. SPU projects under the plan would not be major sources of emissions of air, noise, and/or toxic/hazardous materials.

Implementation of the proposed plan would reduce or limit future increases in sewage backups and overflows throughout Seattle. The sewer maintenance and renewal/replacement programs would reduce discharges from leaks, breaks, clogging, and anticipated failures of the City's aging sewer pipelines. The CSO reduction program of the Wastewater Systems Plan would reduce the frequency and volume of CSO discharges of untreated wastewater into Seattle water bodies, to an average of one untreated discharge per CSO outfall per year. The CSO reduction program would directly improve water quality over existing conditions, and would indirectly benefit aquatic resources and habitat, public health, and use of beaches and water-based recreation.

Taken together, the various programs and strategies in the Wastewater Systems Plan would cumulatively reduce the overall discharges of waste materials in Seattle. The long-term effect would be a positive impact. Long-term benefits to the environment would occur at a slower rate or not at all if the Wastewater Systems Plan were not implemented.

Proposed measures to avoid or reduce such increases are:

Future programs and projects under the Wastewater Systems Plan would reduce the long-term discharges into the environment. The nonproject actions associated with plan implementation are not expected to result in substantially increased discharges to water; emissions to air; production, storage, or release of toxic or hazardous substances; or production of noise. Therefore, mitigation measures would not be required.

2. How would the proposal be likely to affect plants, animals, fish, or marine life?

Implementation of the Wastewater Systems Plan would result in a long-term, net improvement for plants, animals, fish, and marine life, primarily through the CSO reduction program. The CSO reduction program would directly improve water quality over existing conditions, which would improve aquatic habitat in Seattle streams, lakes, and the Puget Sound. Improved aquatic habitat would be a benefit to marine mammals, shellfish, birds, aquatic vegetation, and fish, including threatened and endangered species. The sewer maintenance, renewal/rehabilitation, and capacity improvement programs would have negligible effects on biological resources. Long-term impacts on fish, wildlife, and vegetation would not increase under the Wastewater Systems Plan.

Proposed measures to protect or conserve plants, animals, fish, or marine life are:

Long-term adverse impacts on plants, animals, fish, and marine life are not expected under the Wastewater Systems Plan, and therefore mitigation measures are not required. All future projects under the plan would undergo SEPA review and obtain applicable permits and approvals related to biological resources, which could include site-specific mitigation measures.

3. How would the proposal be likely to deplete energy or natural resources?

Implementation of the Wastewater Systems Plan would not likely deplete energy or natural resources. The programs and future projects under the plan together would not require any major increase in long-term regional energy use. Future wastewater facilities likely to be implemented under the plan would use mostly electricity, primarily at pump stations. Replacement of mechanical equipment in pump stations would not likely increase existing electrical demand to the pump stations, and the new equipment likely would be more energy-efficient. Any potential increase in energy use would be unavoidable and would be minor compared to regional energy supplies. No new power sources would be required.

Proposed measures to protect or conserve energy and natural resources are:

The Wastewater Systems Plan implementation would not result in adverse long-term impacts on energy and natural resources, and mitigation measures would not be required. Future SPU wastewater and CSO facilities could incorporate conservation and efficiency measures into their designs, and be consistent with City's sustainable policies where applicable. New construction and major renovations would be designed and built in a sustainable manner, and projects would be evaluated based on the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) Rating System.

4. How would the proposal be likely to use or affect environmentally sensitive areas or areas designated (or eligible or under study) for governmental protection; such as parks, wilderness, wild and scenic rivers, threatened or endangered species habitat, historic or cultural sites, wetlands, floodplains, or prime farmlands?

The Wastewater Systems Plan implementation would not result in substantial long-term impacts on environmentally sensitive areas, protected areas, and historic and cultural resources. Such resources are not expected to be permanently displaced under the future wastewater programs and projects contemplated under the plan. The CSO reduction program of the Wastewater Systems Plan would result in improved water quality over existing conditions, which would benefit water-based parks, threatened and endangered species habitat, and wetlands. Some CSO reduction projects could be located in Seattle parklands, although the largest CSO storage structures would be underground. Prime farmlands are no longer present in Seattle.

Proposed measures to protect such resources or to avoid or reduce impacts are:

Implementation of the Wastewater Systems Plan would not result in long-term adverse impacts on these resources, and mitigation measures would not be required under the plan. Future SPU wastewater and CSO projects under the plan would evaluate site-specific mitigation measures for historic, cultural, or archaeological resources, if encountered. Future SPU projects located in environmentally sensitive areas also would be evaluated under the Seattle critical areas ordinance, which could include site-specific mitigation measures for environmentally sensitive areas. Potential CSO projects within parklands would be designed to minimize impacts, and would be coordinated with Seattle Parks and Recreation.

5. How would the proposal be likely to affect land and shoreline use, including whether it would allow or encourage land or shoreline uses incompatible with existing plans?

The Wastewater Systems Plan is a nonproject action of wastewater programs and actions that would not directly affect land and shoreline use in Seattle. The plan could indirectly affect future development and growth in Seattle. The City has prepared and adopted Seattle's Comprehensive Plan, which was last updated in 2004. The

Comprehensive Plan guides future land and shoreline uses, and contains a number of policies directing future development to several high-density urban villages. The Utilities Element of the Comprehensive Plan also contains goals and policies for the City's wastewater and stormwater collection. These utilities policies and areas of future growth identified in the Comprehensive Plan were considered by SPU during development of the Wastewater Systems Plan. The plan is consistent with the Utilities Element of the Comprehensive Plan. The proposed Wastewater Systems Plan therefore is compatible with the utilities, land use and shoreline goals and policies in Seattle's Comprehensive Plan, and would not result in any direct or indirect adverse impacts on Seattle's utilities, land use, and shoreline plans and policies.

One of the important requirements of the Growth Management Act (GMA) is concurrence, which requires public infrastructure, including sewage collection, to be in place to serve new development. Most of the City's existing wastewater system has been planned and sized to serve the City's maximum build-out conditions, and would be adequate to serve the level of growth anticipated in the Comprehensive Plan. In several areas of the City, however, hydraulic restrictions would limit system capacity (see Figure 1-2 of the Wastewater Systems Plan). Implementation of this Wastewater Systems Plan would address these capacity issues, and provide the full degree of service called for in the Comprehensive Plan. The Wastewater Systems Plan therefore is consistent with the GMA's requirements for concurrency with Seattle's Comprehensive Plan.

Proposed measures to avoid or reduce shoreline and land use impacts are:

The nonproject actions associated with the proposal would not result in direct or indirect adverse impacts on shoreline and land uses, and therefore mitigation measures would not be required. Design, construction, and operation of the future wastewater projects would comply with the City of Seattle land use, zoning, and shoreline codes and policies, which could require site-specific mitigation measures.

6. How would the proposal be likely to increase demands on transportation or public services and utilities?

Implementation of the Wastewater Systems Plan would directly affect the public services provided by SPU. The Wastewater Systems Plan would decrease the occurrences of sewer backups, drainage problems in combined sewer areas, and CSOs in the City of Seattle. The decrease in these occurrences would benefit SPU's customers and the environment, which would not be considered a significant adverse impact.

The Wastewater Systems Plan implementation would not likely increase long-term demands on transportation or other public services and utilities. Future wastewater projects of the type required to implement the plan are not expected to generate traffic and increase the long-term use of the Seattle transportation network. The proposed Wastewater Systems Plan would reduce the number of sewage backups and overflows, and the renewal and replacement (R&R) program would reduce anticipated failures of the City's pipelines under public streets. By reducing overflows, pipeline failures, and unplanned repairs in streets, implementation of the Wastewater Systems Plan would be a long-term benefit to the City's transportation network. Improved maintenance, reduction of the rate of future sewage backups and overflows, and the renewal and replacement (R&R) program could reduce the frequency of spills and the overall need for public services to control and cleanup spills. Long-term demands on other public services and utilities would be negligible.

Proposed measures to reduce or respond to such demand(s) are:

The nonproject actions associated with the Wastewater Systems Plan would not result in long-term, adverse impacts on transportation, public services, and utilities, and therefore mitigation measures would not be required.

7. Identify, if possible, whether the proposal may conflict with local, state, or federal laws or requirements for the protection of the environment.

The City of Seattle, in implementing the Wastewater Systems Plan, would comply with all applicable local, state, and federal laws and regulations. The proposed plan is consistent with, and supports all local, state, or federal laws or requirements for the protection of the environment. The design, construction, and operation of any future wastewater project arising under the plan would meet applicable laws for protecting the environment. Future projects would obtain all permits and approvals.

SEATTLE PUBLIC UTILITIES
WASTEWATER SYSTEMS PLAN

APPENDIX K
STAKEHOLDER WORKSHOP MEETING SUMMARIES

Project Issues, Challenges, and Decisions
As Identified in October 22, 2004 Stakeholder Kickoff Workshop

During the October 22 Stakeholder Kickoff Workshop, participants were asked to identify key issues and challenges and decisions that will affect development of the plan. Participants wrote down their issues, and the project team grouped them into the following areas:

- Timing
- Policy Issues
- Coordination and Integration
- Triple Bottom Line
- Communication
- Data
- Level of Service
- Funding and Finance

The issues identified and the project team's response to those issues follows.

Issues	Draft Response
Timing Peoples' concerns covered such things as how to address areas that currently have problems, areas that have been under-funded, timing of addressing problems over time, and development of future CIPs.	The planning process currently underway is looking at near term (6-year CIP period) and long term (20-year horizon). SPU will respond on an on-going basis to critical and urgent problems. Since the planning will be focused on known problems, the planning team will be coordinating with operations to develop problem solutions. Some urgent problem areas are being addressed during plan development such as the Madison Valley area. In the plan, these areas will be addressed in the evaluation criteria and respective weighting. The implementation schedule will be determined by availability of funding, though options will be explored that could accelerate implementation.

<table>
<tr><th>Issues</th><th>Draft Response</th></tr>
<tr><td>Policy Issues
There were a number of policy issues raised, many of which pertained to public/ private ownership and responsibilities. There were also some questions regarding the relationship of stormwater and wastewater, for example should we separate stormwater from wastewater to increase the capacity of the wastewater system.</td><td>Side sewer policies will be evaluated as part of the Policy Review, and alignment with overall SPU wastewater service policies.

In regard to sewer separation, the planning goal is to consider separation in terms of impact on the Level Of Service (LOS). The value would be assessed in terms of Net Present Value of “gained” capacity in contributing to closing LOS gaps. Other options such as measures to reduce the current demand on the system will also be evaluated.</td></tr>
<tr><td>Coordination and Integration
The need for coordination/integration was specifically mentioned in regard to:
Storm water and wastewater
King County
SDOT projects
The City’s Comprehensive Plan</td><td>The adopted LOS within the drainage plan will be the starting point for the Plan in regards to the relationship between surface water and wastewater management, and will be evaluated in the alternatives analysis.

We anticipate close coordination with King County throughout the development of the Plan.

The process for coordinating with other City Departments will be identified in the CIP development/implementation process.

The City Comprehensive Plan will be used to identify growth areas that will be assessed in terms of capacity of the existing system.</td></tr>
<tr><td>Triple Bottom Line
There were several questions regarding how to control costs while maximizing benefits and protecting the environment.</td><td>The Plan will build upon the work in SPU’s Triple Bottom Line Manual, and work with SPU economists to monetize environmental and social issues to the extent practicable. This will be part of the evaluation of Plan alternatives.</td></tr>
</table>

Issues	Draft Response
Communication Issues raised about communication focused on: • Timely and effective communication with stakeholders • Effective communication with the public, including ratepayers.	The objective of the workshops is to distill the key information and present it to the stakeholders, and receive feedback from them on that information. A schedule of key decision points for involvement of the stakeholder groups is shown at the end of this matrix. The Plan's project team will be responsible for soliciting feedback and communicating with stakeholders, and it is expected that stakeholders will communicate with senior management and their peers. Focus groups and public meetings will be used to help get the message out to stakeholders and the public
Data One issue important to the group was to use data consistent with the City's Comprehensive Plan, in particular, forecasted job and population growth throughout the City. A second issue was the need for better knowledge of the wastewater system itself. Finally, there was a request for benchmarking/identifying best practices in other cities or jurisdictions	The City Comprehensive Plan is a starting point for identifying land use/development changes and thus potential base flow and storm flow changes. The future projections from PSRC incorporated in the Comprehensive Plan are the starting point. Sensitivities of those projections on alternatives will be considered in the evaluation process. In regards to understanding the wastewater system, the starting point is to evaluate the hydraulics of systems downstream of known overflows. This will provide a framework for additional analysis if required. In regards to benchmarking, the focus of the Asset management approach adopted by SPU is based on Best Practice and a comparison with 'best in class' Utilities, including the input from the QualServe review (a structured review of SPU practices by US-based peer agency personnel) and the WSAA (Water Service Association of Australia) self assessment relative to Australian Utilities best practices.

Issues	Draft Response
Level of Service Stakeholders asked what is the starting point Level of Service, whether that would be achievable (what is the "real" LOS), how can we set a LOS that would be acceptable, understandable to the public and obtain buy-in by the City Council.	Initial levels of service have been defined on the basis of current SPU policies and current system performance. A key objective of the plan is to evaluate those service levels against the cost and environmental and social effects of closing service level gaps. The intent is to develop service levels that maximize ratepayer value at minimum life cycle cost. Targets will be based on triple bottom line and quantified tradeoffs between competing values and objectives. We will also be working with customers to identify the service levels that are most important to them and what they are willing to pay for different service levels.
Funding and Finance Participants were concerned about who will pay for system improvements, ensuring that such decisions are equitable, that there is funding for environmental and social concerns, and that there will be an exploration of financing/funding mechanisms.	The value based decision model will address environmental and social issues through evaluation of alternatives against the "triple bottom line" which considers social and environmental costs. As the potential financial needs of the Plan for LOS gap closure and sustaining current LOS are developed, the Plan developers will work closely with finance to identify other possible funding sources.

Key Stakeholder Workshops	
Meeting Purpose	**Tentative Date**
Provide input into developing value model (i.e., valuing non-monetary aspects of alternatives	Apr-05
Comment on presentation of methods to calculate risks that affect cost and comment on refined value model	May-05
Comment on value model and cost risk results	Jul-05

Meeting Notes

SPU Wastewater Systems Plan
September 9, 2005 External Stakeholders Meeting

Attendees

Name	Organization/Application	Phone/Email
Andrew Lee	Brown & Caldwell	(206) 749-2270/ahlee@brwncald.com
Jessica Motta	SDOT CPRS	jessica_motta@seattle.gov
Greg Izzo	SDOT CPRS	greg.izzo@seattle.gov
Lish Whitsen	DPD	lish.whitson@seattle.gov
Dori Costa	SDOT PPMP	dorinda.costa@seattle.gov
Cheryl Eastberg	Parks	cheryl.eastberg@seattle.gov
Bob Swarner	KCWTD	bob.swarner@metrokc.gov
Meg Moorehead	Council	meg.moorehead@seattle.gov
Jackie Kirn	OPM	jackie.kirn@seattle.gov
Bob Anderson	COWCAC	ander_r@comcast.net
L.E. “Ted” Hilton	COWCAC	(206) 937-6188/marinecamelia@yahoo.com
Keith Hinman	SPU	keith.hinman@seattle.gov
Karen Huber	King County	(206) 684-1246/karen.huber@metrokc.gov
Mike O’Neal	BC	(206) 749-2294/moneal@brwncald.com
Terry Kakidu	SPU	(206) 615-0507/terry.kakidu@seattle.gov
Dan Pitzler	CH2M HILL	(425) 233-3592/dan.pitzler@ch2m.com

Comments and Discussion

- What effect will Brightwater have on reducing overflows? – Because of the way flows are currently re-routed from West Point to Rendon, Brightwater will have little effect on reducing overflows in the city.
- Does changing LOS affect size of “circles” on capacity map?
- SDOT - are the street benefits calculated? They don't see much overlap of the capacity priority areas to current SDOT planning (at least at this scale) except the S Lake Union area – maybe with more detailed look other locations would be identified.
- Demand management may help in certain areas
  - Pilots are ongoing. What are others doing?

- What effect do detention facilities have?
- Are private costs considered in making cost/benefit decisions? Yes.
- Have impact to other City services (e.g., streets) been considered? Yes, to the extent detail is available.
- King County is interested in coordinating on Demand Management programs. Recent I/I study has some ideas
  - Most potential benefit from side sewers.
- Customers need more information about their side sewers and their responsibilities
  - Next year. Outreach to realtors, lenders, homeowners.
  - Is City considering a "for fee" side sewer inspection program?
- Opportunities exist for City/King County coordination on Demand Side programs and pilot results.
- Good to define backups clearly for City and County – KC designs so that there will be no surcharge above crown of pipe.

Mike O'Neal Additional Notes

Nancy Ahern - Should compare the general risk of backups due to side sewer blockage [(800-80)/Total # Customers] to the risk related to Capacity caused backups [*this could apply to all causes for that matter*]. Regulations will govern over customer LOS.

General Discussion around LOS - a lot of interest in this topic. People were trying to grasp the difference between the stated LOS frequency and storm event especially King County. The point not necessarily made or completely recognized is that a once in 20 occurrence is more stringent than a hydrological statistical event frequency i.e. a 20-year frequency storm event can occur more often than once in 20 years plus the storms of even lower frequency (25-year, 50-year, etc etc)

Storm Drainage General Discussion - a number of questions and comments related to the storm drainage element. I thought there was some confusion over presenting the SD LOS because most people that commented seemed to think in terms of water on the street and may not have understood that LOS available is limited by capacity of the Combined Sewers - which was noted as only 1-4% was less than the 20-year event but also seemed not to be that well understood. S Moddemeyer however, did note the limited nature of current deficiency of LOS and suggested that Env Justice may be a consider more than cost benefit calculation.

K Huber - KC survey indicates that customers are willing to pay whatever so that overflows do not occur. [*HOWEVER, the neighborhood around KC's Murray Ave PS objected to a KC project, preferring the once per overflows to the project!*] KC was very interested in the demand management ideas and effectiveness of detention. KC issue is peak flow mitigation, volume is much less an issue.

SEATTLE PUBLIC UTILITIES
WASTEWATER SYSTEMS PLAN

APPENDIX L
SUMMARY OF ASSUMPTIONS USED FOR ANALYSES

BROWN AND CALDWELL

Memorandum

Seattle Public Utilities
Long-Range Wastewater Plan

MEMORANDUM

Date: 8/1/05

To: Martha Burke, SPU

From: Andrew Lee, Brown & Caldwell

Copy to: Mike O'Neal, Brown & Caldwell

As part of the SPU long-range plan, a number of analyses were performed. Those analyses were as follows:

1. 25-year Cost Projections
2. Economic Life Analysis for Sewer R&R Program
3. Hydraulic Level of Service (LOS) Analysis
4. Comparison of O&M, Capital (Capacity), and R&R Expenditures

In order to complete the four analyses, a number of assumptions were made. This memorandum concisely summarizes those assumptions and the basis for making them. Tables 1 and 2 present the assumptions used to develop the 25-year wastewater cost projections. Table 3 presents the assumptions used in the economic life analysis for developing the sewer renew and replace (R&R) program. Table 4 presents the assumptions used to develop the hydraulic level of service (LOS) or "pipe capacity" analysis. Table 5 presents the assumptions used to compare operations and maintenance (O&M), capital, and R&R expenditures.

Table 1. 25-year Cost Projection Assumptions – CIP Projects

Category	Assumption	Source
Capital Cost Inflation	3% compounded annually from 2006.	ENR Construction Cost Index
LOS Priority 1	Replacement of existing sewer with larger pipe. 5 year LOS achieved over 10 years.	B&C analysis
R&R Scheduled	Scheduled dependant on condition assessment, risk and cost.	B&C analysis
R&R Spot Repair	Reactive to condition or collapse of those sewers not found economical to replace.	B&C analysis
Additional CSO	Future projects in other basins	To be provided by Sharpley (SPU)

Category	Assumption	Source
CSO	2006-2007 from SPU CIP. Projections from Estimated CSO Project Budget and Schedule, 2001 Plan Amendment Update and Beyond.	SPU. Estimated CSO Project Budget and Schedule, 2001 Plan Amendment Update and Beyond.
General Wastewater	2006-2007 from SPU CIP. Future costs included in LOS and R&R project estimates.	2006-2007 from SPU CIP.
Sediment Remediation	2006-2010 based on SPU CIP. Estimated $200,000 per year after 2010 based on 2010 CIP.	2006-2010 based on SPU CIP.
Sewer Rehab	From SPU 2005-2010 CIP. Future costs included in LOS and R&R project estimates.	From SPU 2005-2010 CIP.
Alaskan Way Viaduct	2006-2007 from SPU CIP. Projections from SPU Conveyance and Treatment Option. 2009 land purchase. Outfalls, permitting and pipes phased over 7 years starting 2010. CSO treatment and PS phased over 3 years starting 2018.	2006-2007 from SPU CIP. Projections from SPU.
Sound Transit	2006-2008 from SPU CIP. Estimated $300,000 per year after 2008 based on average of 2006-2008 spending.	2006-2008 from SPU CIP.
Other	Includes $2.8 million for IT and $2.3 million for Fleets & Facilities per year	Provided by Thibert (SPU)

Table 2. 25-year Cost Projection Assumptions – Revenues, Expenses and Customer

Category	Assumption	Source
O&M Inflation	3% compounded annually from 2006	General inflation
Bond Interest Rate	5.5%	Leanne Galati (SPU)
Bond Term	30 years	Leanne Galati
CIP Funding	75% debt funded and 25% Pay-As-Go	Leanne Galati
Current Debt Payment	Equal annual payments paid off in 2022	Leanne Galati
O&M Costs	From Drainage and Wastewater Fund (DWF) O&M Budget 2005/06	From DWF O&M Budget 2005/06
Taxes	Equal to 11.87% of income based on the 2006 budget	2006 budget
Claims Cost	Calculated claims costs resulting from implementing Economic Service Life R&R strategy	B&C Analysis
CSO O&M	$3 million per year starting in 2007 for monitoring	Provided by Sharpley
CCTV	Required to verify and validate R&R projects. Estimated $200,000 per year.	B&C Analysis
King County Rates	2006 - $25.60	King County from Lienesch
	2007 - $26.92	King County from Lienesch
	2008 – $31.04	King County from Lienesch
	2009 - $34.39	King County from Lienesch
	2010 - $37.34	King County from Lienesch
	Post 2010 – 3% increase per year	King County from Lienesch
RCE growth	No growth projected	Jerry Allen
Other revenues	None projected.	

Table 3. Sewer R&R Economic Service Life Analysis Assumptions

Category	Assumption	Source
Pipeline Probabilities of Failure		
Vitrified Clay Pipe Probability of Failure	Weibull curve for vitrified clay (VC) pipes has a beta of 120 years, an alpha of 3, and a first fail of 20 years.	SPU Critical Sewer Model 2004
Concrete Pipe Probability of Failure	Weibull curve for concrete pipes has a beta of 100 years, an alpha 3, and a first fail of 20 years.	SPU Critical Sewer Model 2004
Pipeline Consequence of Failure Costs		
Planned Repair Costs	Planned spot repair costs were taken from the calculations performed in SPU's Critical Sewer Model. The Critical Sewer Model calculated spot repair cost based on depth of pipe. Multiplication factors were used to increase the repair cost based on location, diameter, slope, proximity to major sewer users, and other factors.	SPU Critical Sewer Model 2004
Emergency Repair Costs	Emergency (unplanned) repair costs were assumed to be twice (2x) the planned repair cost.	Discussion with Terry Martin.
Claims Costs	Claims costs were assumed to be $13,500 per backup. It was assumed that one failed pipeline would lead to one backup, and therefore one claim.	Discussion with Martha Burke and Sewer Backup Maintenance Strategies (Terry Martin, 2005)
Political/Social Costs	Sensitivity analyses were run using political/social costs equal to $0, $30k, $50k, and $96k per backup. It was assumed that one failed pipeline would lead to one backup. $96k per backup was assumed to be the upper boundary value for political/social cost per backup. $30k per backup was the political/social cost per backup used in the recommended R&R program.	$96k per backup was the political/social cost calculated for the Madison Valley project, based on the $10 million capital project that is planned to address the flooding.
Distribution of Failures for Critical Sewer pipes	It was assumed that when critical sewer pipes (those inspected every 5 years) experience a failure, 97.5% of the time the failure results in a planned repair, 1.25% of the time the failure results in an emergency repair, and 1.25% of the time the failure results in an emergency repair and a backup with associated claims and political/social costs.	SCARP Memo, confirmed during discussion with Terry Martin
Distribution of Failures for Non-Critical Sewer pipes	It was assumed that when non-critical sewer pipes (those not inspected) experience a failure, 25% of the time the failure results in a planned repair, 40% of the time the failure results in an emergency repair, and 5% of the time the failure results in an emergency repair and a backup with associated claims and political/social costs.	Discussion with Terry Martin and Calibration to the Number of Claims associated with sewer failure each year (7).
Pipeline R&R Costs		

Category	Assumption	Source
Pipe Replacement Costs	Pipe replacement costs were based on pipe diameter and depth. It was assumed that the construction method for pipe replacement was open cut dig and replace. Tabula, a program used by King County, was used to calculate cost for open cut construction of new pipe. Costs were developed for a variety of pipe diameters and two categories of pipe depth, between 0 and 16 feet and greater than 16 feet. The costs were compared with SPU's costs and were found to be consistent. Construction costs were multiplied by 1.15 and 1.4 to produce total project costs. These additional costs include soft costs such as taxes, engineering, construction management, and contingency.	Tabula (King County Planning Level Estimating Tool)
Pipe Rehabilitation Costs	Pipe rehabilitation costs were based on costs for cured-in-place pipe (CIPP) by *Insituform*. *Insituform* is the world's largest trenchless technology company with a proprietary method for lining sewer pipes. In addition to the base price for installation of CIPP from *Insituform*, traffic control, sewer bypass pumping, cleaning, and cost for lateral connections were added. Cleaning costs were estimated assuming $0.25/linear foot/inch diameter and lateral connection were $250 per connection every 20 feet of pipe length. Traffic control and bypass pumping were calculated using *Means*. Construction costs were multiplied by 1.15 and 1.4 to get project costs. These additional costs include soft costs such as taxes, engineering, construction management, and contingency.	*Insituform, Means Construction Cost Estimating Guide*
Number of Pipelines in Analysis		
Missing Pipelines in Databases	Two different databases were used to calculate R&R costs and consequence of failure costs. The Critical Sewer Model was used to calculate consequence of failure costs and a GIS database of pipes was used to calculate R&R costs. Because there were discrepancies in the two databases, a small percentage of pipelines did not have the economic life analysis performed for them. For VC pipelines, the analysis was performed on 89% of the pipelines. For concrete, the analysis was performed on 68% of the pipelines. To account for the remaining pipelines, the cost stream for VC pipes was multiplied by 1.13 (=1/0.89), and the cost stream for concrete pipes was multiplied by 1.46 (=1/0.68).	
Pipeline Materials	The analysis was performed only for VC and concrete pipes since VC and concrete pipes account for 93% of the system. To account for the remaining 7% of pipelines of other materials, the final cost streams were multiplied by 1.07.	
Pipeline Matrix		
Pipeline Categorization in Economic Risk Matrix	The economic service life calculation was not performed on each individual pipe segment, since there were over 39,000 pipes in the database. Instead, pipes were categorized into 360 categories based on three factors: (1) pipe age/material, (2) pipe consequence of failure cost, (3) pipe R&R cost. The economic service life calculation was performed on those 360 categories, and the results were applied to each individual pipe segment based on the category it fell into.	

Table 4. Hydraulic Level of Service (LOS) Analysis Assumptions

Category	Assumption	Source
Wet Weather pipe flows	Peak flows in mainline pipes are a function of the: 1. Upstream length of pipe as a surrogate for area 2. Land use and pipe type (combined, separated, partially separated) 3. Runoff predicted by the Santa Barbara Unit Hydrograph method or previous I/I analyses	SPU GIS; King County; MSG Engineering Precipitation analysis; Existing Infoworks models
Sanitary flow growth	Separated areas: increase in population accounted for Combined/Partially separated: Increase in total flows associated with growth were found to be two significant digits smaller than runoff flows and were generally ignored.	BC analysis
Capacity Assessment	Pipes for which computed peak flows exceeded the Manning's capacity were tested using a simplified hydraulic calculation to estimate the rise in water level (hydraulic grade line) caused by the excess flow. Only pipes for which the water level was estimated to rise to within 10-feet of the ground surface were selected as "capacity challenged."	BC analysis
Prioritization	Pipes not meeting the identified requirements were prioritized according to: 1. Association with previous backup reports and claims 2. Coincidence with growth areas 3. Relative impact measured by number of potentially affected parcels and number of pipes in a neighborhood. 4. Association with major future projects or developments (e.g. Viaduct replacement) 5. Association with known problem areas	SPU GIS Model calculations SPU Operations staff

Table 5. Comparison of O&M vs. Capacity vs. R&R Expenditures Assumptions

Category	Assumption	Source
Benefits and Costs of Increased O&M to Address O&M-Related Backups		
Number of Backups Reduced by Increased O&M	It is assumed that moving from Strategy B (status quo) to Strategy C (recommended strategy) will result in 15 fewer O&M-related backups.	*Sewer Maintenance Strategies Memorandum by Terry Martin, 4-29-05*
$ Benefits of Increased O&M	Benefits for increased sewer maintenance are based on the reduction in costs for reactive maintenance, reactive CCTV inspection, claims costs (assume $13,500 per backup), potential regulatory non-compliance costs (assume $1,000 per backup), and environmental/social costs (assume $3,000 per backup) by moving from Strategy B (status quo) to Strategy C (recommended strategy).	*Sewer Maintenance Strategies Memorandum by Terry Martin, 4-29-05*
$ Costs of Increased O&M	Costs for increased sewer maintenance are based on the increase in costs for proactive (schedule) maintenance, proactive grease abatement, and proactive CCTV by moving from Strategy B (status quo) to Strategy C (recommended strategy).	*Sewer Maintenance Strategies Memorandum by Terry Martin, 4-29-05*
Net present value of benefits and costs	The Net Present Value of increased sewer maintenance was calculated assuming a 50 year timeframe and a discount factor of 5%.	SPU PDP Guidance

Category	**Assumption**	**Source**
Benefits and Costs of R&R to Address Sewer Failure-Related Backup		
$ Benefits of R&R	Benefits (ie, Avoided Risk Costs) for R&R projects were calculated by subtracting the net present value (NPV) of the risk costs of failure for the recommended R&R program from the NPV of the risk costs of failure for the do-nothing alternative. The risk costs of the recommended R&R program and the do-nothing alternative were calculated using the Economic Service Life Model created by Brown & Caldwell. The model assumed a timeframe of 75 years.	
$ Costs of R&R	The Costs were determined by calculating the NPV of all scheduled sewer rehabilitation (ie, replace or reline) activities based on the Economic Service Life Model created by Brown & Caldwell. The model assumed a timeframe of 75 years.	
Net present value of benefits and costs	The Net Present Value calculations assumed a discount factor of 5%.	SPU PDP Guidance
Benefits and Costs of Capital Projects to Address Capacity-Related Backups		
Annual Number of Backups Avoided by Capacity-Related Capital Projects	It was assumed that the annual number of backups avoided by a capacity-related capital project is equivalent to the number of capacity-deficient pipe segments replaced in the project multiplied by the storm frequency to which the pipe segments are deficient. In other words, if a project is going to replace 10 pipe segments that do not meet the 5 year storm-design level of service, then the project will reduce 10 x 1/5 = 2 backups per year.	
Timing of Backups Reduced by Capacity-Related Capital Projects	Since a 10-year timeline was assumed for replacing pipes that do not meet the 2-year LOS, the reduction in backups and the associate benefits (ie, cost reductions) were staggered over the 10-year timeline. The full benefit of replacing all 203 pipe segments was not achieved until year 10.	
$$ Benefits of Capacity Projects by Avoiding Risk of Storm Overload Backup	Benefits for Capacity projects by avoiding risk of storm overload backup were calculated by multiplying the annual number of backups avoided by a capacity-related capital project by avoided claims costs ($13,500 per backup), avoided potential regulatory non-compliance costs ($1,000 per backup), and avoided environmental/social costs ($3,000 per backup). These costs per backup were based on the assumptions from Sewer Maintenance Strategies by Terry Martin.	*Sewer Maintenance Strategies Memorandum by Terry Martin, 4-29-05*
Net Present Value Calculation	A discount factor of 5% and a 50-year timeframe was used in the NPV calculation.	SPU PDP Guidance